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The What's New magazine

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APRIL
1983

Japan's
fifth-generation
computers:
**MACHINES
THAT THINK
LIKE PEOPLE?**

Smokey's amazing 150-hp 2-cylinder auto engine

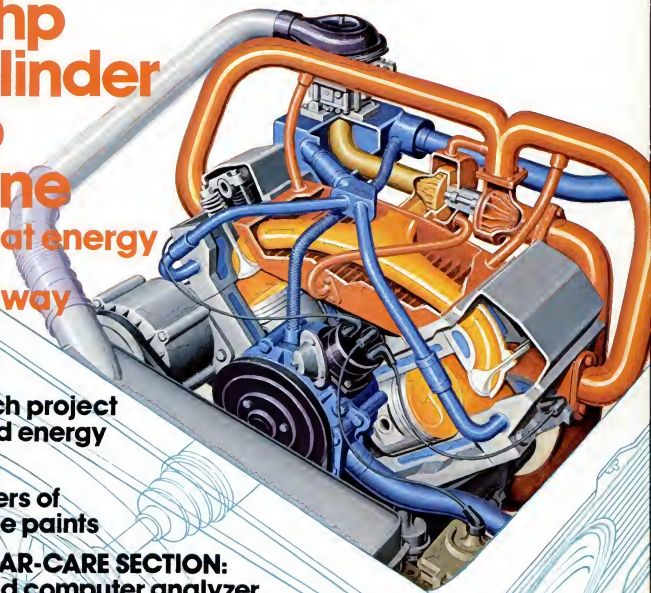
uses heat energy
others
throw away

Giant Dutch project
stores wind energy
in the sea

The wonders of
water-base paints

SPECIAL CAR-CARE SECTION:

- Hand-held computer analyzer
- Gas-charged shocks
- Pocket paging alarms



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04



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This One



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HIGHLIGHTS OF THIS ISSUE

Smokey's amazing 150-hp, 2-cylinder engine

This clean-running 60-mpg marvel uses heat energy others throw away. PAGE 82

Machines with common sense

Recall HAL from 2001? A system to rival "him" may be here by 1992. PAGE 78

First test report on the revolutionary plastic tire

It outperforms radials at almost every turn; here's our exclusive story. PAGE 100

Gigantic Dutch project: sea storage for wind energy

Two-in-one scheme will combine wind and water to generate 5,000 MW. PAGE 85

PS special section: car-care news

Computer analyzer, gas-charged shocks, paging alarms, more. STARTS PAGE 115

Water-base finishes fight fire, rust, and condensation

New alkyds, urethanes, and acrylics do oil-paint jobs—sometimes better. PAGE 106

COVER PAINTING BY RAY PIOCH

PS SPECIAL SECTION: CAR-CARE NEWS

Computer analyzer taps your car's brain	115
Protect your car, truck, or van —install a pocket paging alarm	119
Gas-charged shocks tame tight turns and sudden bumps	122
Spot-weld gun for auto-body work	128
Easy-to-make belt tightener	129

CARS AND DRIVING

318i: a better Bavarian?	25
Sporty small sedans: Now economy cars are performers, too	45
Ride monitor measures vehicle bounce and shake	71
Smokey's amazing 150-hp, 2-cylinder engine	82
First test report on the revolutionary plastic tire	100
Ignition interrupter	172

ENERGY NEWS

Barreled sunshine for crop drying	8
Mortar-veneer solar collector	14
Gigantic Dutch project: sea storage for wind energy	85

COMPUTERS AND ELECTRONICS

Machines with common sense: I. superchips	78
Machines with common sense: II. fifth-generation computers	78
Touch-screen communicator puts the world at your fingertips	103
Spelling checkers—electronic dictionaries for your computer	145

NEW PRODUCTS AND INVENTIONS

Space-age magnets make for bait casting without backlash	27
New gadget up the Japanese sleeve: wrist TV	32
Two folding bikes	59
Infrared gas grill	109
Two-cylinder chain saw	114

What's New DIGEST

Trim ultralight	88
Buried lab	89
Mini-drone	90
What's new in boating	91
What's new in tools	92
What's new in home improvement	93
What's new in electronics	94
What's new for your car	95

HOME AND YARD

Long-arm tiller for tight spots	62
Heavy-duty tractor saves time	75
You can transform a tract house	96
Build extra living space within your present walls (Part III)	104
Water-base finishes: New ones fight fire, rust, condensation	106
Put spring in your mower	110
Earth-bermed wood foundation	112
Jig, band, or saber —match the saw to the job	137
Easy-steering workhorse	142
Low-cost hydro-drive tractor	143

REGULAR FEATURES

PS readers talk back	4
Detroit report	13
Science newsfront	19
Bits & bytes	30
Housepower clinic	38
Through the viewfinder	61
"Say, Smokey—"	64
PS/What's news	77
Taking care of your car	130
Shop talk	164
Wordless workshop	166
PS readers' product information	188

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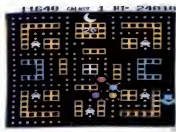
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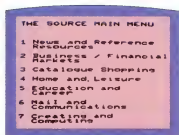


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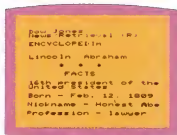
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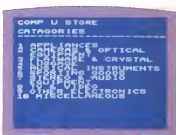
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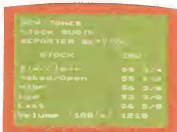
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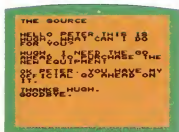
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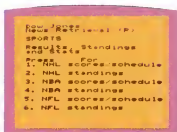
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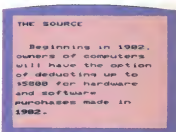
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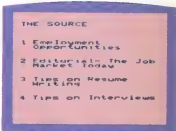
GAMES



**TRAVEL
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**EMPLOYMENT
OPPORTUNITIES**



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PS READERS TALK BACK

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Weapons for peace—or war?

Kevin J. Parker decries the cost of missiles when people are poor, hungry, and illiterate [RTB, PS, Jan.]. It sounds as though he thinks that food, shelter, and education are practical needs, but that missiles are not. I believe there is absolutely nothing more practical or of higher priority than a weapon to defend yourself when a criminal is right outside your door. It allows you to live another day, without which no thought of food or other social needs is possible.

Philip Coates, New York, N.Y.

Given the recent batting average of the U.S.S.R. in Afghanistan and Poland, I would ask Parker this: Would he really rather have every dwelling in the U.S. re-insulated than have the safety net that the MX missile would provide? I hope he realizes that, under Russian control, a magazine of such high caliber as POPULAR SCIENCE would not be available to the general public. But you can be sure that Russian scientists and weaponry producers are reading PS—including Parker's letter.

Roy Bellon, Los Angeles, Calif.

Like Parker, I read POPULAR SCIENCE to keep in tune with developing technology. But my captivation with technology has been dulled somewhat as I have become more aware of the role it plays in developing instruments of mass destruction. To me, the accelerating nuclear-arms race will not protect the free world, as some claim, but will much more likely guarantee the destruction of everything we hold dear.

I believe that POPULAR SCIENCE could play an important role by clarifying the nuclear armament-disarmament issue in its broadest sense—by not only discussing technical aspects but by also focusing on secondary effects such as the brain drain from civilian R&D and the resulting effects on our economy. By effectively treating this subject, you will provide a service to Americans and all humanity.

Adolf Andres, Selkirk, Man.

Boise geothermal

Readers of your excellent article "Hot Water Power" [PS, Jan.] may be interested in the geothermal system we in Boise, Idaho, have been using since 1893. An underground piping system distributes natural hot water to about 250 patrons in an area about one-quarter mile wide by two miles long. The water is pumped from two 400-foot-deep wells at 170 degrees F, then piped to the users through insulated mains installed under the city streets. Al-

though our water is not sold as potable, it is as pure as the city's domestic water. As such, we do not have the severe corrosion problems noted in your article. Many of our patrons use the hot water for kitchen, laundry, and bathing.

Besides this system, the state of Idaho has recently installed a separate well and distribution system to heat the state capitol and surrounding government buildings. Also, the city of Boise is installing a third system to heat the city hall, stores, office buildings, and residential units in an area adjacent to the state's system.

T. O'Rourke, Chairman
 Boise Warm Springs Water District
 Boise, Idaho

Aviation pioneer

It was bad enough when they changed the name of Northrop Strip at White Sands. It is too much for you to spell it wrong ["Invisible Bomber," PS, Feb.]. Northrop, not Northrup, Corp. is named for Jack Northrop, a wonderful man and aviation pioneer whose flying wing of 35 years ago was years ahead of its time.

John E. Breyman, Hobbs, N.M.

Fiat and colorful

I was fascinated to read about the new black-and-white wristwatch TV ["What's New," PS, Nov. '82], which uses very small LCD elements to make up the picture. Then I wondered: Why couldn't a flat color TV be made by having a backlighted film tinted with small red, green, and blue dots precisely covered by equal-sized LCD elements? A small computer could vary the amount of voltage going to each dot. The less they got, the brighter each would appear. Is this possible?

Chris Halsall, Williams Lake, B.C.

John Free replies: "Yes. In fact, we diagrammed a similar scheme in a March '75 article on flat-screen TV. It was being researched in Japan, and no doubt liquid-crystal versions have been enhanced since. For more detailed information on Suwa Seiko's monochrome device, see 'Wrist TV' in this issue."

Tesla's legacy

A remarkable man of science, Nikola Tesla, died 40 years ago, on January 7, 1943. Yet, despite his inventions of the first alternating-current motor, the system of AC power transmission, radio control, and maybe even the first practical radio, Tesla has been all but ignored by most histories of science and by the science establish-

Continued

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(Continued)

ment. This year, however, the U.S. Postal Service will issue a commemorative stamp in Tesla's honor. Let's hope that this is only the beginning of a movement to assure belated recognition of this eccentric genius.

Edson André Johnson, La Canada, Calif.

POPULAR SCIENCE enthusiastically covered Tesla's accomplishments both during his lifetime and in a special retrospective [PS, July '56] on the hundredth anniversary of his birth.

Aping nature

Those who construct ultralight aircraft such as the Solair I ["10 Hot New Planes," PS, Dec. '82] might benefit from a close look at insect-wing venation and the architecture of bird bones and feathers. Designers of fiberglass fishing rods and boat hulls have already successfully incorporated such natural designs into their products.

E. L. Rittershausen, Nyack, N.Y.

Say watt?

I am planning to remodel my bathroom soon, so I read your article "Brighter Bathrooms" [PS, Jan.] with interest. The annual energy saving quoted for switching to fluorescent lighting fixtures seems exaggerated, however. Substituting a 40-watt fluorescent for four 40-watt incandescent may give the same light output, but I would have to light that bulb constantly for almost 3½ years to realize the \$130 saving listed (at my utility's recently increased rates). Since I don't leave my bathroom lights on all the time, it would take some four decades to achieve the saving. Does General Electric know something we don't?

D. T. LaMont, Hamilton, Mont.

It's our fault. The dollar saving stated for that example and one other is not realized annually but over the life of the fluorescent bulb (20,000 hours for a 40-watt soft-white fluorescent, 9,000 hours for a 20-watt). GE's calculation is based on an electricity cost of six cents per kilowatt-hour and takes into account additional wattage consumed by the fixture's ballast. Other lamp-substitution examples are given in a GE listing of energy-saving home-lighting tips. For a free copy, write to Inquiry Bureau, General Electric Co., Nela Park, Cleveland, Ohio 44112.

Caution on eutectic salts

As a general contractor specializing in the design, sale, and installation of conservation and solar systems, I believe that your article on eutectic-salt placement [PS, Jan.] will lead many designers astray. While these salts do store and release heat when operated across a phase-change temperature, in practice they have some major problems that lead to skepticism for your installation recommendations.

Potential users should keep in mind

that the technology is still experimental, that available products may not perform as well as claimed, and that the salts are highly corrosive. Recently, a customer wanted me to build foil-packed phase-change materials into the ceiling of his new home. I would not even consider installing such an unproven, potentially damaging product in such an unserviceable location. There are other potential problems in the installations you show. If used in a floor, the salts must not be covered by plants or furniture. If in a greenhouse or sunspace, they must be insulated from the sunspace at night. If they are to be charged by air flow, the quantity must be copious and well distributed. For best effect, we've found, phase-change materials should be directly charged by waste or unusable heat.

I hope your article does not set off a rush of clients wanting us to install phase-change salts. Despite new products with exotic-sounding techno-names, we almost always find that application of basic energy principles—orientation, insulation, landscaping, etc.—is more cost-effective and reliable.

Michael Luttrell, Ra Energy
Napa, Calif.

Air-safety idea

I was surprised to learn recently that the exact cause of the Flight 90 crash in Washington, D.C., was never determined, but that overloading with snow and ice may have been the prime reason. This reminded me of an idea I had at the time of the accident. As a free-lance cinematographer I have done a lot of flying, on both scheduled and chartered flights. I've often wondered how the pilot could be sure that the weight of the aircraft was within safe limits—since luggage is no longer weighed in and the pilot must try to judge the weight of ice and snow on the plane. Why not build a scale into the landing-gear system that would read out on an instrument gauge? This way, the pilot would know at all times whether his load was within safe limits before taking off. I believe this system could also be used to indicate how rough the last landing was. The gauge would register the force of impact and hold the maximum reading until the landing gear could be checked for any possible damage.

Edwin Ahbe, Rogers, Ark.

Corrections: The GrafTalk business-graphics software package ["Bits & Bytes," PS, Jan.] was not written exclusively for distribution by Lifeboat Associates. The program is also currently distributed by its publisher, Redding Group Inc. (609 Main St., Ridgefield, Conn. 06877), and by Westco (25 Van Zant St., Norwalk, Conn. 06855).

The photos illustrating "Faster Fire Sprinklers" [PS, Jan.] should have been credited to the San Clemente (Calif.) Fire Department. They show tests conducted by the department, and not of a fire in San Francisco as the caption stated. ■

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Barreled sunshine for crop drying

The time is fall 1992, and you are driving through the western wheat country. You stop for a moment to watch the massive harvesters roll in and discharge their golden cargoes of grain. To prevent spoilage, the grain must be dried quickly, but the leaden skies and chill in the wind hold no promise of natural drying by the sun.

In years past, the landscape hereabouts was punctuated by huge, silver tanks filled with propane to fire roaring grain dryers. They're gone

now, replaced by rows of ordinary-looking drums labeled "Barreled Sunshine." The tanks contain dehydrated salts that, when mixed with water, release controlled chemical heat to dry the grain.

That's the way it could be, says Wallace Minto, the well-known inventor of the Freon car [PS, Oct. '70, Aug. '73], if his plan for storing solar, geothermal, or waste heat in dehydrated metal salts were put to work. The trouble with solar energy, says Minto, is that it often comes at the wrong times and places. His recently patented system would allow the energy to be stored and transported to where it's needed. Moreover, the system would allow the stored energy to be released at temperatures higher than it was collected at, thus extending the usefulness of low-temperature heat sources.

Minto's patent lists 10 metal salts that might be used. All of them hydrate (acquire moisture) readily. The moisture can be removed by heating, after which the anhydrous salts can be stored indefinitely, no differently from a barrel of cement or other dry substance. When the moisture-proof container is opened and liquid is again brought into contact with the salts, the heat originally used to dry it is released. The drying-and-rehydration cycle of the salts can be repeated over and over. The chemicals don't wear out.

How much heat can be stored? Aluminum fluoride has the greatest energy density: 194,000 Btu per cubic foot. Magnesium sulfate, common Epsom salts, has a potential of 50,000 Btu per cubic foot.

Unlike other common methods of heat storage—rock pits, water tanks, phase-change materials—chemical salts can yield much higher temperatures than the original input. Solar collectors and other alternative-energy systems are most efficient at relatively low temperatures. Minto's system could use these low temperatures for dehydration—Epsom salts dehydrates at about 140 degrees F, for example.

And since returning the water to the salt is a chemical action in which the rate can be controlled, the heat can be withdrawn at a faster rate than it was stored. Solar heat stored over several days can be recovered in a few hours, yielding temperatures as high as 705 degrees.

That's high enough to encourage Minto to speculate about uses other than crop drying. For instance, the system might prove attractive for steam generation, he says.—E. F. Lindsley

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**BEFORE YOU TURN
THIS PAGE, FORGET
EVERYTHING
YOU KNOW ABOUT
LAWN MOWERS.**

LAWN-BOY

THERE'S NEVER BEEN ANYTHING LIKE TOTALLY REDESIGNED TO WORK WITH

You're going to find that our new Lawn-Boy mowers may be the best we've ever made. And there's good reason.

It's called ergonomics—a study that determines how machines can be designed to work more efficiently with the way the human body works.

What we've learned enabled us to build blade-control mowers for 1983 that feel, are easier for you to use than older blade-control mowers. Simply because we've made our controls easy to reach, comfortable to handle, simple to operate.

WE'VE BUILT IN BLADE-CONTROL, WITH ONE OF THE MOST COMFORTABLE HANDLES YOU'LL EVER GET YOUR HANDS ON.

These 1983 Lawn-Boy mowers have a control system that stops the blade within three seconds of when you take your hands from the normal operating position.



With Lawn-Boy you have a choice of three convenient, comfortable-to-use blade-control systems: manual restart, electric restart, and a blade brake clutch system that stops the blade while the engine continues to run.

There's something else that makes our Lawn-Boy blade-control systems special. They're engineered into our mowers as an integral part of the design. The result is Lawn-Boy blade-control systems operate with great efficiency and reliability.

And we invite you to try the blade-control handles on other mowers. When you do, your hands will tell you there's none as comfortable to use as ours.

WE'VE MADE LAWN-BOY EVEN EASIER TO START.

We did it by adding technical advancements to the engine, like sonic limited compression release, solid-state ignition and vented bowl carburetion. Technical terms that simply mean that our new blade-control Lawn-Boy mowers are even easier to start.



THE '83 BLADE-CONTROL LAWN-BOY. THE WAY YOUR BODY WORKS.

How about electric start mowers? We've improved those, too.

In fact, Lawn-Boy electric start blade-control mowers are so dependable that the manual starter has been removed. Our new electric start systems have a solenoid and a 12-volt battery that's the same arrangement used in cars. We also increased the alternator output so it can replace in the mower's battery the charge used in starting with minutes of running.

WE'VE ALSO ADDED OVER A DOZEN OTHER IMPROVEMENTS TO OUR '83 BLADE-CONTROL MOWERS.

Since we were committed to totally redesigning our mowers, obviously we couldn't stop with just easier starting and blade-control.

So we didn't. Handles are wider, for easy maneuvering.

We've included a high-performance blade that not only mows cleaner, but also helps bag heavy, high-moisture grass.

And our new Lawn-Boy blade-control mowers have our *Whisper Soft* muffler that makes an already quiet mower even quieter. And the muffler is built in under the mower's deck, so you cannot accidentally touch something that's too hot to handle.

Our list of improvements goes on. Improvements that make our '83 blade-control mowers the best Lawn-Boy mowers ever built.

LAWN-BOY HAS A DURABLE, LONG-LASTING TWO-CYCLE ENGINE WITH PROVEN RELIABILITY.

For nearly 30 years, Lawn-Boy has manufactured two-cycle engines specifically for lawn mowers. They're American made with a well-earned reputation for dependability.

The proof?

In a side-by-side endurance test, our engine proved it's designed to last 50% longer than the four-cycle engines used on most other mowers.

And when it comes to two-cycle engines, ours are designed from experience.

For example, the most reliable crankshaft you can find on a two-cycle engine is a solid, one-piece, forged crankshaft. Ours is. It's also surrounded by precision needle bearings to

help increase usable horsepower by reducing friction.

Our aluminum cylinder block is die cast around its cast iron cylinder sleeve then carefully machined to provide cool running and long engine life.

All of this may sound like so much engineering jargon to you. But we feel the terms used are ones you should know about and ask about when considering a mower with a two-cycle engine. The reason? They stand for improvements that our 30 years of experience have proven to work best in lawn mower engines.

So, a mower with a better engine, easier starting, easier maneuvering, greater dependability than any Lawn-Boy ever made: a mower that ergonomics helped redesign from the grass up; a mower that's backed by trained service dealers.

What does it all mean?

That there's never been a mower quite like the '83 blade-control Lawn-Boy.

Buy yours, and as time goes by, you'll know why.



FOR 1983, THERE'S A BIGGER SELECTION FROM LAWN-BOY TO BETTER FIT YOUR MOWING NEEDS.



SUPREME—This top of the line gives you the versatility of a mower that lets you side discharge, side bag, rear bag, Mow-N-Mulch™ and shred leaves with the addition of optional accessories. Plus, it gives you the choice of push or self propelled, 19 or 21-in. widths, blade-control systems and a unique mower deck design. Shown is the 21-in. self propelled side bagger with the clutch system.

COMPACT SUPREME REAR BAGGER—This 20-in. manual restart mower is new to the Lawn-Boy Supreme line. It has a big, easy-to-empty bag that fits between the handles, so the mower can trim close on either side. It's ideal for rear bagging.

MULCH-R-CATCH®—It's a rear bagger. Or it's a bagless mower. This mower has a patented deep orbital chamber deck that mows clippings so fine you don't have to bag them. And the Mulch-R-Catch quickly converts from a bagging mower to a mulching mower without tools. Shown is the 21-in. self propelled with electric start.

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for name of your nearest Lawn-Boy dealers. Please be prepared to give your zip code number.

\$30* **SPECIAL INTRODUCTORY OFFER!** worth of free accessories with the purchase of a new Lawn-Boy Supreme or Mulch-R-Catch® mower.

Present this coupon when you purchase a new Lawn-Boy Supreme or Mulch-R-Catch mower at the regular price. Participating Lawn-Boy dealers will give you \$30 worth of Lawn-Boy accessories of your choice. Or ask your dealer for the terms and duration of his offer. Offer not valid with the purchase of any other Lawn-Boy models. Offer Expires: June 30, 1983.

Clip and present to participating dealer at time of purchase.

NAME

ADDRESS

CITY STATE ZIP

PARTICIPATING DEALER

Model Purchased ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ Serial No. ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Date
Purchase required. Expires 6/30/83. Offer may not be available in conjunction with other promotions. Ask your dealer for details.

*Manufacturer's suggested list price.



LAWN-BOY®

As time goes by, you'll know why.

Lawn-Boy. A Product Group of Outboard Marine Corporation, Galesburg, Illinois 61401. © Outboard Marine Corporation, 1983. All rights reserved. Printed in USA. Lawn-Boy mowers comply with the Consumer Product Safety Commission safety standards for walk behind power lawn mowers. Plus, Lawn-Boy mowers display the Outdoor Power Equipment seal, signifying Lawn-Boy mowers voluntarily meet or exceed the current ANSI B71.1 safety standards for rotary mowers.

DETROIT REPORT

By JIM DUNNE

Performance comeback

Detroit is moving to bigger engines to improve performance in its economy cars. Ford has plans to enlarge the 1.6-liter (97.6 cu. in.) Escort four to 1.9-liter (115 cu. in.) displacement within 18 months. Chevy wants a 2.2-liter (134.2 cu. in.) version of its recently enlarged two-liter (122 cu. in.) four used in Cavalier and other J-cars. The aim is to change the bland performance of small cars and trucks into something exciting. Why now? Because Detroit thinks it has solved the fuel-economy problem, and because the allure of high performance still exists with new-car buyers. Look for other engines to be enlarged, as well, since fuel economy will suffer little in the change thanks to electronic controls, fuel injection, and effective gear ratios.

Teuton turnaround

"We Malibu-ized the Rabbit too much," says Jim Fuller, who's in charge of VW's U.S. operations. "Now we're going back to its German features—firmer seats, firmer suspension." VW sales in the U.S. have been depressed in the past 12 months, and the company is moving to make a turnaround. In addition to actually changing the product, VW will change its image. "We got away from the old VW flavor in our ads," explains Fuller. "Now we will go back to the idea of our 'Germanic engineering heritage.'"

Divisional identity

In a couple of years, GM divisions will have more-exclusive body styles designed to create greater differences within the company's lineup. One major example: Starting with the 1985 model year, Olds and Pontiac will drop their X-body models while Chevy and Buick will continue to sell the X-body Citation and Skylark. Olds and Pontiac will have a new car, code-named the N-body. The N should make its first appearance in 1985 as a two-door coupe. To further strengthen its distinctive identity, Pontiac will also sell Fiero, its two-seat plastic sports model, through 1986.

Biting the bullet

That's what Ford is doing by closing its West Coast assembly plants and assigning more production to plants east of the Rockies. After closing the San Jose assembly line, the farthest west that Ford will assemble cars is St. Louis. The company has no plans to reopen any of the

three California lines that once built cars for the West Coast. "We were back-shipping 60 percent of our Escort production east of the Rockies," a Ford executive explained. "It doesn't make sense to ship parts out to California to put on cars that are being shipped right back." The boom in Japanese sales on the Coast is cited as the primary reason for the closings.

An American Jetta

VW will put Jetta sedans into production in the U.S., starting with the 1985 model, to make full use of its New Stanton, Pa., assembly plant. The Jetta will be built on the same line as the American Rabbits and will be the second VW product built in this country. Poor sales of the high-volume Rabbit have cut production in half at New Stanton, so there is plenty of room for the new line.

Plastic parts

Your new car will have more plastic parts in coming years as auto makers continue to move to lighter materials. The goal is to cut weight to improve fuel economy. The use of fiberglass will go up by more than 50 percent. Plastic will continue to be used in greater amounts in instrument panels, lightly loaded under-hood structural bracing, and exterior body panels. Also, look for more applications in chassis and suspension parts. Springs and even loaded structural members will be switched over. In 1982 the industry put 224.4 million lbs. of reinforced plastic into new cars. By 1986, it's estimated that more than 392 million lbs. will be used.

Too many Ks?

Chrysler, more than the other auto makers, is not so sure that front-wheel drive is the complete answer for its future lineup. There may still be room for rear-drive cars. That means the company will attempt to keep its rear-drive sedans and coupes, such as Imperial and Gran Fury, in production for the foreseeable future instead of dropping them in favor of smaller, more-fuel-efficient K-car variants. Two big reasons for the change in thinking are the lowered price of gasoline and the need for variety in its lineup.

Soft body lines

Thunderbird's soft body lines are part of Ford's reaction to the boxy-styling period when Thunderbirds and Lincolns took on hard, angular lines. You'll see more soft-line styling next year when the 1984 Mark

VII is unveiled. Its shape will be much like that of the T-bird, except that the grille will be similar to today's Mark and the trunk will have the spare-tire-bulge trademark. The change to aerodynamically efficient shapes is a highly controversial one that threatens to create the dull sameness angular lines did.

Engine enigma

Talk of turbine and rotary engines is seldom heard around Detroit anymore. Even the electric, the darling of the energy solvers, is on the back burner. The reason: Standard piston engines are easily meeting fuel-economy and emissions goals. In addition, Detroit knows now how to get more power out of small piston engines without sacrificing fuel economy. And with the present availability of gasoline, the pressure for an alternative engine is greatly eased. Are turbine- and electric-motor programs a failure? Yes, if you recall that the goal was to have alternative engines in production cars by the early or mid-1980s. Turbines and electrics are as far from production right now as ever. As for rotaries, only one manufacturer, Toyo Kogyo (Mazda), builds them for production. It has yet to prove that the rotary is superior to the piston type.

Panel puzzle

When instrument-panel styles are compared, Japan seems to be going one way, while Europe is heading in another. The Japanese trend is to more digital readouts and graphics in front of the driver. Europe has a reserved look, with basic analog gauges and dials continuing to dominate the cluster. Critics say the Japanese way appears too gimmicky and the European way too conservative. Look for this to be resolved with two separate information centers: one with the traditional gauges in front of the driver, the other off to the side in an information center that will display only on demand. Detroit is schizoid and seems to be moving in both directions, although a compromise has evolved in some domestic cars—especially the newer GM models that favor the European look.

Diesel-particulate trap

Build one that works, and the auto world will beat a path to your door. That seems to be the situation as GM tries to meet stricter regulations for reducing the amount of particulates (pieces of unburned carbon) in diesel exhaust. The EPA wants the current 0.6-gram-per-mile standard cut to 0.2 gpm by 1985, and GM says it can't come up with a solution in time. Until now, GM has used traps made from foam, metal mesh, ceramic fiber, or honeycomb monoliths like catalytic converters to catch the exhaust particles. But these experimental types have to be cleaned out every 50 miles or they clog up the exhaust. You can burn the particles away with 1,100-degree-C (2,012 F) heat, but that takes a reburning system and produces extreme temperatures under the car. Got a better idea? **EJ**

ADVENTURES IN ALTERNATE ENERGY

Alternative to copper plates:

mortar-veneered solar collector



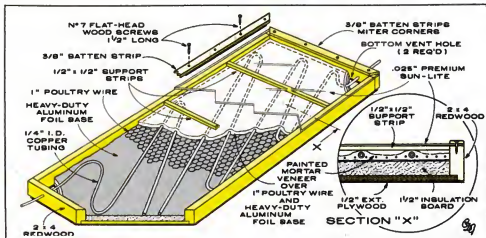
Tubing in a bed of cement heats water for less

By DANIEL RUBY

For years, Rodney Lentz read all he could about solar energy, doodled designs on scratch pads, and talked a good game to his family and friends. Then, when he moved to a new home in Battle Mountain, Nev., he could delay no longer. He decided to go ahead with his design for low-cost, mortar-veneered solar collectors.

"The idea behind my collectors is to get around the need for expensive copper plates and time-consuming brazing and soldering," Lentz says. Instead, copper tubes are embedded in a veneer of black-painted mortar. The rough-textured material makes an excellent absorption surface, he explains, but its heat-conduction capacity is lower than that of metal plates. Thus, he built the collectors one-third larger than would normally be required for the storage capacity. This is not a great penalty, however, because the \$4.50-per-sq.-ft. cost of the collectors is so low compared with that of more-efficient types.

The collectors are coupled to the home's existing 55-gallon hot-water tank in a direct, open-loop system. A differential thermostat controls the pump and a drain-down valve to empty the loop when freezing threatens.



The panels are constructed as shown. Redwood 2x4s form the three-by-eight-foot frames, which are rabbeted to accept plywood backing. Urethane insulation board fits snugly against the back (two cutouts in the corners allow ventilation when the system is shut down), and heavy-duty aluminum foil covers the entire inside to reduce heat absorption by the wood and to seal the collector space from fogging vapors. Poultry netting, stretched and stapled to the frame, serves as a base for the mortar. The copper tubing lies over the netting. It is carefully laid out and positioned to give the greatest possible length (40 feet) while maintaining uniform distribution and proper drainage slope (1/4 inch per foot of tube length). The mortar is a standard mix of one part

portland cement to three parts clean sand to one-half part lime. It's troweled on to a thickness of about 1/4 inch, except where it laps over the tubing. When dry, the mortar is sprayed with high-temperature flat-black paint and the entire assembly covered with a sheet of Kalwall Sunlite glazing.

The collectors have performed beyond Lentz's expectations, producing nearly all of his family's hot water and saving 600 kilowatt-hours during the first three months of operation.

There is just one problem with the system. It is a permanent fixture at the Nevada house, but the Lentzes have since moved to north-central Washington state. No matter. Having overcome solar inertia once, Lentz is now happily back at the drawing board.

America's Best.



Winston. America's

A person wearing a green helmet and goggles is shown in profile, holding a small electronic device. The background features a vibrant sunset or sunrise scene with orange and blue hues. The overall image has a dark, moody atmosphere.

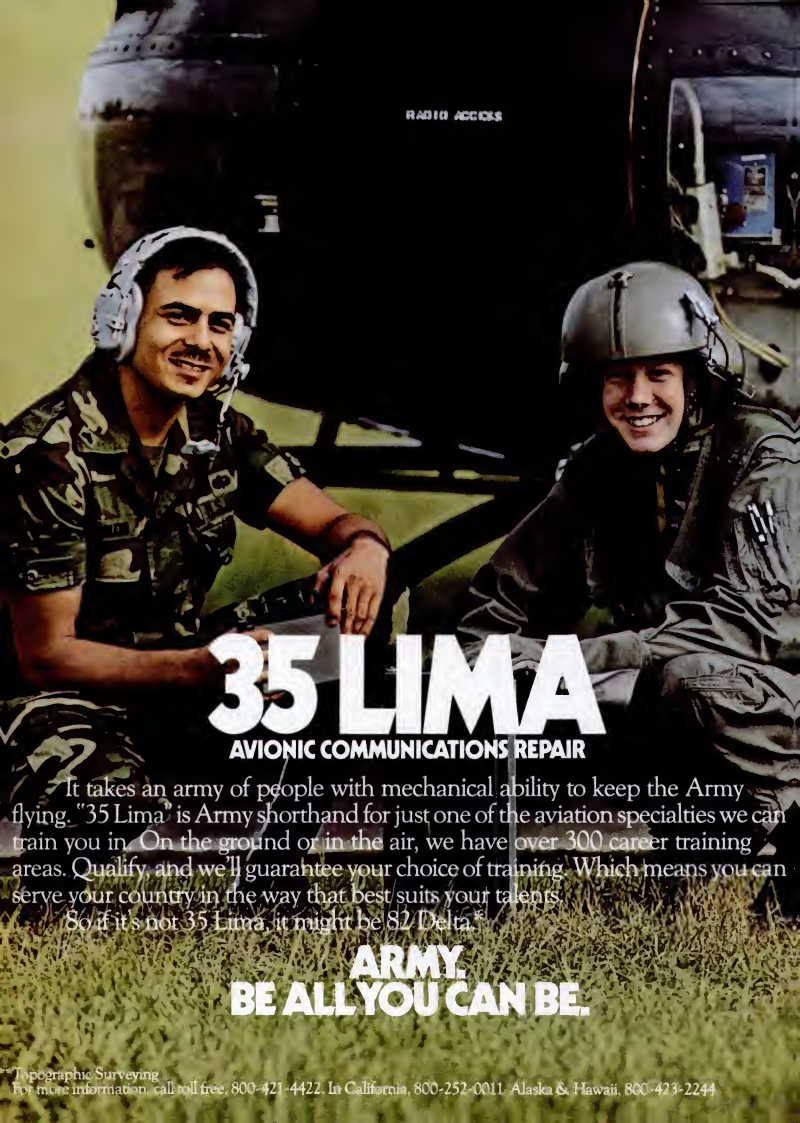
TS: 9 mg. "tar", 0.7 mg. nicotine, LIGHTS 100's: 12 mg. "tar",
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s Best.



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Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.

A color photograph of two men in military flight gear. The man on the left is wearing a camouflage flight suit and a headset, smiling. The man on the right is wearing a grey flight suit and a helmet, also smiling. They are sitting in front of the open bay of a military aircraft. The background is dark and industrial.

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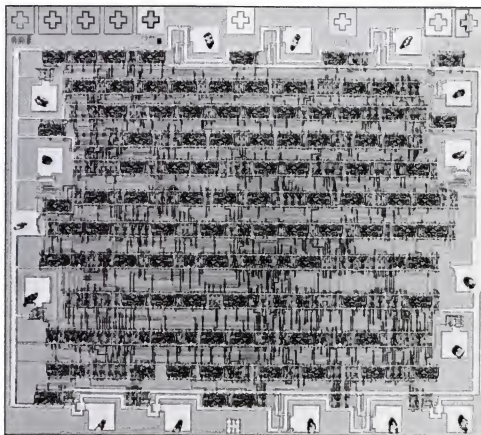
So if it's not 35 Lima, it might be 82 Delta.*

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SCIENCE NEWSFRONT

By ARTHUR FISHER



Microelectronic chip

The article on superchips in this issue describes the way chip technology has progressed from mere integrated circuits to today's VLSI—very-large-scale integration. The photomicrograph above shows a further step in the inexorable march toward miniaturization of electronic components: an experimental circuit only $\frac{1}{4}$ inch on a side, with internal structures only 1.2 microns in size, a step that the folks at General Electric have cunningly dubbed AVLSI, for *advanced* very-large-scale integration. The circuits, developed at GE's Research and Development Center, are fabricated using the technology known as CMOS, or complementary metal-oxide semiconductor. They will be available in volume by 1985 for applications in aerospace, industrial robots, and other factory equipment, where their greater immunity to noise will be an advantage.

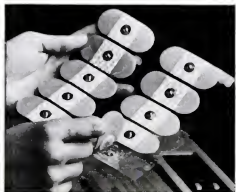
Tokamak fusion progress

Physicists at Princeton University's Plasma Physics Laboratory got just the Christmas present they had asked for. At 3:06 a.m. on December 24, they turned on the Tokamak Fusion Test Reactor, a \$314 mil-

lion behemoth—and it worked. The TFTR is one of this country's leading entries in the fusion-energy race, designed to generate in 1986 more energy than it consumes (scientific break-even) [PS, May '82]. In this initial test, the machine turned a puff of hydrogen gas into a cool plasma that lasted only a 50,000th of a second. Eventually, the TFTR will turn a fuel mixture of tritium and deuterium into a plasma hot enough, and for a long enough time, for fusion reactions to occur.

Disposable diagnostics

Critics of our throwaway society have more and more lamented the waste of



valuable, recyclable materials, especially metals, which may be energy-intensive to produce and increasingly scarce.

Which brings us to ask Hewlett-Packard, maker of the disposable pictured in the photo at the bottom of the page, whether this throwaway was really necessary. What you're looking at is a bunch of HP 40420A diagnostic electrodes for electrocardiograms. Because they are pre-gelled and self-adhesive, they can save a technician's time; they eliminate the need for suction devices, straps, and patient preparation. But each electrode contains a stainless-steel sensor. And in quantities of 1,000, each one costs 28 cents.

Plant-genetics advance

Molecular biologists at Monsanto Company in St. Louis have for the first time induced plant cells to produce foreign proteins, a step that one of them, Dr. Robert Horsch, describes as "an important breakthrough in plant-genetic engineering. . . . It will now be possible to introduce virtually any gene into plant cells with the ultimate goal of improving crop productivity."

The Monsanto group used a variation of recombinant-DNA techniques that have been worked out at many laboratories all over the world [see "Designer Genes" and "High-tech Plants," PS, May '82]. What they achieved was the transference of antibiotic resistance from bacteria to cells of petunia and other plants. They isolated from bacteria the genes that confer immunity to a specific antibiotic (kanamycin, often used as a marker in recombinant-DNA research). They joined these genes to another piece of DNA to form a combination called a chimeric gene, and then inserted it into a soil bacterium, *Agrobacterium*, which has the very special ability to inject its genetic material into plant cells. When petunia cells were mixed with the soil bacteria, they incorporated the chimeric gene. And when these petunia cells were grown on a culture medium with a normally lethal dose of kanamycin, they survived.

Antibiotic-resistant petunias will not be a boon to mankind. But the techniques used here, once mastered, should enable plant biologists to transfer to economically important plants a whole gamut of desirable characteristics, including pest-resistance, improved nutritional value, self-fertilization, and faster growth. And those advantages will help the world overcome pressing food and energy shortages.

Avalanche rescue system

The lives of skiers and mountaineers buried by an avalanche can be saved with a new electronic system developed at Stockholm's Royal Institute of Technology. Self-adhesive stickers attached to each person's boot contain a miniature antenna and a diode. They reflect microwave signals emitted by a transponder carried by a helicopter rescue team. The system pinpoints a victim's location even when he is buried under more than 30 feet of snow.

Continued

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Lightweight electric staple gun that works on standard household current. Easy-squeeze trigger-fast operation makes it tireless for women to use as well as men.

Manual or electric... Arrow Staple Guns make fast, effortless work of those do-it-yourself home fix-up projects! Easy one hand operation leaves other hand free to hold, stretch and control material for that professional finishing touch... whether you're a handy homemaker insulating an attic or a handy homemaker covering a valance. Both models use Arrow No. T-50 staples in 6 sizes: 1/4", 5/16", 3/8", 1/2", 9/16" and Ceiltile.

Available at all leading Hardware, Home Center & Discount Department Stores everywhere.

Arrow Fastener Company, Inc.
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Science newsfront

[Continued]



Photography freezes water

This remarkable picture sequence was made by S. Richard Oyama and colleagues at Lockheed Missiles & Space Co.—where Oyama is group leader in photo instrumentation—as part of a demonstration of high-speed photography. They rigged a cable from the dart over a pulley to trigger a one-microsecond strobe light. When the dart punctured the water-filled balloon, the strobe captured the situation seen in the right-hand photo: Although the stretched skin of the rubber balloon has retracted, the water inside has yet to lose its shape and collapse.



periodically by the car's engine. Among the several companies participating in the project, Owens-Corning Fiberglas is helping to design the flywheel and will provide parts made of composite materials.

Ultra-foam

The Department of Energy has filed a patent application on a new foam developed at Sandia National Laboratories. Shown emerging from a generator nozzle in the photo below, the new foam is extremely stable. Just five percent of the water-based foam sinks to the bottom of a container in an hour; after six hours, it has lost only half its volume. By contrast, half of a typical fire-fighting foam drains in 30 minutes.

Flywheel hybrid auto

A team of university researchers and their industrial partners are trying to double the city mileage of a conventional car by converting it to a hybrid with both a flywheel and a continuously variable transmission (CVT). That goal was specified in a two-year contract awarded to the University of Wisconsin by the Lawrence Livermore National Laboratory. Headed by Professor Andrew Frank of the University's Department of Electrical and Computer Engineering, the project will raise the city mileage of a 1980 Phoenix compact from 24 mpg to 48 mpg.

During the first phase of the project, the designers will adapt an Australian CVT, made by Ifield engineering. According to Larry O'Connell, who heads the Livermore Transportation Systems Research Program, "The Ifield design shows promise of having the best performance. It is quiet and efficient." Professor Frank anticipates this step alone will boost mileage 25 percent, from 24 mpg to 30 mpg.

During the second phase, a flywheel made of steel and fiber-composite materials will be installed. It will spin at 12,000 rpm and store up to 0.25 kilowatt-hours of energy. The flywheel will both recover braking energy and be spun up





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(Clockwise from upper right):
Nissan Long Bed, Nissan
Standard, Nissan King Cab 4x4,
Nissan King Cab 2WD.



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The most power of any standard engine in its class.

More than Toyota, Chevy S-10, Ford Ranger and everyone else.

- Most horsepower: 103 hp @ 4800 RPM.
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Two sparkplugs per cylinder, crossflow hemihead and unique "fast-burn" design give maximum operating efficiency, minimum pollution.
Electric fuel pump for reliable operation in extreme heat.

The most power of any standard 4-cylinder diesel:

Nobody else has a 2.5-liter diesel this brawny.

- Most horsepower: 70 hp @ 4000 RPM.
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- All-new technology for rugged durability and superior performance, built on Nissan's almost two decades of diesel experience gained powering big trucks all over the world.
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Double-wall construction

- Double steel walls (except in 11 MPG standard) prevent damage to cargo box's exterior sheet metal from shifting cargo. Not in Toyota.
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- Bigger payload than many full-size pickups.
- Bigger beds: longer King Cab and longer and wider Long Bed than Ford Ranger.
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- Double rear-wheel Cab & Chassis model: the only compact pickup with factory-installed duals for better stability and handling under load.



Cut-away view

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- New cab seats 3 abreast (except 4 X 4 conventional cab and ST) in new comfort.
- More hiproom than Chevy S-10 or Toyota.
- More legroom than Ford Ranger, Chevy S-10 or Toyota.
- More headroom, legroom, seatback rake adjustment than in any Nissan-built standard compact ever.
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- Sliding rear window available. (Standard on Sport and XE models.)



The Sport Truck that lives up to its name.

- Unique grille and bumper designs for contemporary styling: sleek in 2WD, rugged-looking in 4WD.
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- Day/night antiglare mirror on all Deluxe and XE models...and more.



ONE HECK-OF-A-HUNK-OF-A 4x4.

On-demand 4-wheel drive.

- Shift from 2WD to 4WD High at the flick of a stick—without stopping to lock front hubs. Not in Toyota.
- Highest minimum ground clearance of any compact. Higher than Toyota, Chevy S-10, Ford Ranger.
- New wide-clearance torsion-bar independent front suspension for a smooth, level ride. Unlike any other compact truck before.
- Tightest turning circle for maneuvering in tight spots. Runs rings inside Chevy S-10, Ford Ranger, Toyota.
- Front stabilizer bar; wide rear track for a solid stance.
- Wide radial tires standard: P215/75R X 15.

Everything you could want in a compact truck.

- Automatic transmission with lock-up torque converter for extra efficiency.
- Power steering with tilt column for extra thigh room.
- Sun roof standard on ST and optional on XE.
- Step bumper. And lots more available options.

SPECIFICATIONS 4 WD King Cab	
Wheelbase (in.)	110.8
Length (in.)	187.0
Width (in.)	66.3
Height (in.)	67.1
Min. ground clearance (in.)	8.7
Max. GVWR	4550
Payload (lbs.)	1400
Fuel capacity (gal.)	15.9
Bed length (in.)	73.4
Bed width (in.)	56.9
Bed depth (in.)	15.6

*Mfr's sug. retail price excluding title, tax license and destination charges.
 *Not avail. in Calif. and high-altitude areas.

Nissan 4WD
King Cab



ONE HECK-OF-A SAVER.

Only \$5,995* for the Nissan MPG Standard.
 Big value, little money.

Economy is a tradition at Nissan, and has been for 50 years. That heritage continues this year with quality, advanced technology and standard equipment like radial tires (most models) for reduced rolling friction.

Every Nissan truck gives you solid value for your money, with extra features at no extra cost. Prices start at just \$5,995.* That's less than Toyota, Ford or Chevy, but look what you get:

- 5-speed overdrive transmission.
- Power front ventilated-disc brakes.
- Transistorized ignition for strong starts, low maintenance.
- Maintenance-free battery.
- Brake load-sensing valve.
- Flow-thru ventilation with side-window defoggers; bi-level heater.

Nissan is one heck-of-a-hunk-of-a truck, now at your Datsun Dealer.

NISSAN
WE ARE DRIVEN
DATSUN



318i: a better Bavarian?

MARRAKECH, MOROCCO

A little bit of the old, plus a whole lot more of the new than you can see, are the ingredients in BMW's 318i, the new-for-1983 successor to the 320i sports sedan. A redesign of the front and rear suspension, an improved engine, new styling, and interior refinements are intended to keep the lowest-priced BMW competitive through the balance of the 1980s.

Handling and ride improvements were a top priority. The geometry of the front suspension has been changed, and a wide, sickle-shaped control arm is now used to regulate vertical wheel travel more precisely. At the rear, the new semi-trailing arms are swept back at an angle similar to the bigger BMWs. The pivot points are moved upward to produce smoother initial movement in the springs. Also, coil springs and shock absorbers are separate. They now respond individually and more quickly.

The 107.7-cu.-in. four-cylinder engine now has an L Jetronic fuel-injection system and a fuel-cut-off device that shuts down the engine when coasting above 1,200 rpm. Two transmissions are available: a five-speed manual and a three-speed automatic. Fuel economy is up about two mpg—25 mpg in the city, 36 highway.

In stopwatch-timed zero-60-mph runs at 3,000 feet through the Atlas Mts. between Marrakech and Ouarzazate, with a passenger aboard, I found that times averaged 11.4 seconds.

Overall length is seven inches shorter than the 320i; width is more than an inch greater. Its height is virtually unchanged. The weight of the chassis has been reduced by 200 pounds, mostly through the use of lightweight alloys.

With an aerodynamic coefficient of drag of 0.37, the new model is no leader in its class. But Dr. Karlheinz Radermacher, BMW director of research and development, is not dismayed. "Aerodynamics is being given too much importance, in my opinion. At BMW, styling comes first. We want to maintain the BMW look even if the drag rating goes up."

Inside, the 318i continues the theme of simplicity. Instruments are clustered in front of the driver and are viewed through the top of the steering wheel.—*Jim Dunne*



Stanley gives you a hand when you need it most.



Stanley's new "Flip Drive"™ Ratchet lets you change ratcheting directions with one hand.

Around your home, workshop or garage, Stanley's unique Flip Drive ratchet does with one hand what used to take two. Its patented "Flip Drive" feature lets you change ratcheting directions easily, with one quick flip of a

finger. There's no other drive tool like it. And it's part of Stanley's new line of Workmaster™ Sockets and Wrenches.

The Workmaster line delivers the selection you'd expect. All the most needed drive tools, sockets, wrenches and accessories. And a complete line of sets for a wide variety of jobs. All in reusable packages for

convenient home storage. All featuring Stanley quality for years of performance.

Simplifying do-it-yourself projects and repairs is what Stanley does best. The new Flip Drive ratchet and Workmaster line of sockets and wrenches prove it.

STANLEY

helps you do things right.

It would be heresy to dilute a Canadian this great. So,

Add Naught To MacNaughton



Space-age magnets make for bait casting without backlash

Magnetism—adjustable and permanent—is an invisible brake on spool speed

By JERRY GIBBS

Thanks to NASA and the computer industry, fishermen are enjoying a new state of the art in revolving-spool (bait casting) reels. Last year Daiwa introduced its instantly successful Mag Force reel, and for 1983 Abu-Garcia and Shimano have launched new models with technically attractive features to please the most sophisticated casters. Of greatest interest is the use of magnets to control spool speed and prevent overrunning the line—backlash.

While magnetic spool controls aren't new, the use of small, light, very strong magnets whose life is practically infinite has revolutionized anti-backlash controls. Small magnets of samarium (a rare-earth element) and cobalt are used in space telemetry, computer-memory circuits, and high-tech loudspeakers. Now the angler has joined the fun.

Both Abu-Garcia and Shimano use a proximity system; that is, the magnets (thus the magnetic field) move closer or farther from the reel spool to exert control. Here the similarities end. Abu-Garcia uses a number of magnets arranged concentrically, and their force is applied over a relatively large area of the spool end. Shimano has three more-powerful magnets, whose field is concentrated on a drum extending from the spool end.

Although the Abu-Garcia reel is bulkier, it is faster starting. The magnetic effect doesn't become coercive until well into the cast, when it cuts in rather hard. It is incredibly smooth—the result of both hubs being supported only by ball bearings—and very light lures can be cast.

Shimano is lower in outline, lighter, shaped to the hand. Its magnetic control starts at near the beginning of the cast and at low setting. The fixed spindle on one hub makes it slightly less smooth in rotation.

Both reels still have the traditional friction-type mechanical brake to tame large, runaway fish.

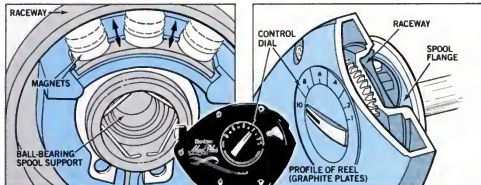
The Abu-Garcia Ultra Mag I (about \$75) features a fast-cast thumb bar, which immediately engages the gears when released. The \$80 Shimano Mag Plus has a model (251) that cranks on the left side, which avoids the need to switch hands on the retrieve.

Line capacity of the Abu-Garcia is 150 yards of 12-lb.-test line; model II holds 225 yards. The Shimano holds 160 yards of 12-lb. line. E



Cylindrical magnets mounted on a plate inside the reel housing control the cast of the Abu-Garcia Ultra Mag reel. Turning the cast-control dial moves the plate toward or away from the reel-spool side plate, increasing or decreasing the magnetic-field effect on the moving spool.

Fishermen who specialize with light or heavy lures can make additional fine adjustments by turning a screw binding the magnet plate, by adding magnets, or by removing some of the magnets. On casting, the pinion gear slips out and the spool rides on just two ball bearings.



More-powerful magnets in the Shimano Bantam Mag reel are mounted on a movable yoke in precise N-S alignment so their magnetic fields reinforce each other. A metal drum extension on one spool flange extends over the magnets. As control from the dial is increased, the mag-

nets are moved upward, closer to the inner surface of the rotating drum. Although the magnet arrangement is fixed, proximity is finely controlled. The Bantam Mag's hub is supported by ball bearings on the magnet end, by a spindle and bearings on the other.



For Your Receiver? Again?

Here's Kenwood's incredible \$520 Audio Purest limited distribution Integrated Amplifier with a thundering 160 watts of power and the most phenomenal 0.005% THD we've ever seen. Price slashed to \$229.

Last year, something very strange happened. 1500 DAK customers hooked Kenwood's top of the line AM/FM Tuner up to their receivers.

It's strange because nobody had thought of hooking a tuner up to a receiver before. But, now for the first time, they're listening to FM stereo with specifications and purity that rival their best records and tapes.

Kenwood's amazed. We sold all 1500 they had in 60 days, and we wished we could have gotten 3000. The only bad part was we had to return hundreds of checks because we ran out of tuners.

Well, DAK's done it again, but even better this time. Instead of just improving the FM portion of your receiver, now you can make a staggering improvement in the sound quality of all of your components.

This time we bought all 2,000 of Kenwood's limited distribution Audio Purest series, 160 watt integrated preamp/amps with Sigma Drive shown above. The sound purity will shatter your conception of what stereo reproduction is all about.

And, best of all, we've cut their \$520 price down by a large cash purchase to just \$229. (That's a \$291 saving.) And we've reproduced Kenwood's actual 1981 price list below to prove our point.

DO YOU NEED IT?

Listen to a favorite record through your receiver. Then hook up this Kenwood masterpiece. You'll hear such a staggering dif-

ference in depth of response and purity you may feel like dropping your old receiver over a cliff. But, please don't because you may still need to use it as a tuner.

It's not just the 160 watts (80 X 2) that creates the startlingly dramatic sound. It's a combination of Kenwood's Sigma Drive, nonmagnetic design, 3 separate power supplies and the High Speed DC amplifier with Zero Switching that makes this integrated amplifier produce such a remarkable musical performance.

LOOK AT THESE SPECS

We've sold 160 watt amps before. And, they were good. The best had Total Harmonic Distortion of just 0.02%. But the Kenwood KA 900 has Total Harmonic Distortion at full output of just 0.005%.

That's nearly 400% better. The frequency response is from DC (that's 0 in English) to 400,000Hz +0-3db. The signal to noise is really remarkable. On phono, for 10mV input, it's 98db, and for tape or 'aux' it's an incredible 105db. But the specifications only tell part of the story.

SIGMA DRIVE

Sigma Drive is a method of including speaker behavior within the scope of amplifier performance. Sigma Drive actually forces the speaker to exactly reproduce musical signals from the amplifier.

Here's how it works. Most traditional amplifiers simply send out a signal. Kenwood has taken a giant step forward. This

amplifier listens to the electrical output of the speakers at the speaker terminals.

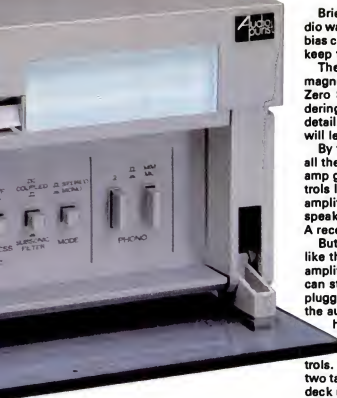
As your speakers respond to music, the movement of the speaker cones causes them to generate their own electrical current. This current, although not the fault of the amplifier tends to block and distort the continuing signal from the amplifier.



With Sigma drive, this amplifier not only sends out a pure signal, it makes sure that your speakers are reproducing it accurately.

Kenwood would be first to admit that these signals are very small, but remember this is top of the line esoteric audio equipment. It's not for the average person.

Through a technique called negative feedback and by using 4 wires to each



speaker (12 foot cables are included or make your own) two wires send out signal to each speaker and two 'read' what the speaker is generating and correct for it.

The 4 wire cables aren't 'super cables'. They merely send and receive information for The Sigma Drive system.

Specifications aside, you'll hear that Sigma Drive literally forces your speakers to deliver accurate, authentic music that will in Kenwood's words "startle even the most experienced listener."

Note: Your speakers will need nothing special. At the speaker terminals two of the wires go to the positive side and two to the ground. At the amplifier, the wires are separated into outputs and sensors.

So, with Sigma Drive it becomes clear that the main job of an amplifier is not to merely amplify a signal, but in reality to exactly drive a speaker as never before.

EVERYTHING ELSE TOO

Dual power supplies are used because Kenwood's tests have shown that when one channel has to reproduce a really heavy signal, it causes a ghost signal to appear in the other channel resulting in a momentary deterioration in THD.

A nonmagnetic design removes previously hidden distortion. Kenwood found that magnetic distortion accounts for a great deal of the poor reproduction quality and general lack of musical detail heard from conventional amplifiers.

High Speed DC amplification produces the cleanest sound yet. Transient intermodulation distortion (TIM) significantly degrades the purity of music. TIM is related to the speed with which an amplifier can reproduce a sharp burst of music.

The conventional slow amplifier cannot do it quickly enough. The result is a lack of clarity or even worse a loss of some of the signal music enveloped in the large dynamic peak (muddy sound).

In conventional amplifiers, crossover or notch distortion occurs for brief parts of a microsecond as audio waveforms switch from + to -. Kenwood has solved this problem with Zero Switching.

Briefly, what happens is that as the audio waveforms move from plus to minus, a bias current is applied to the transistors to keep them from going to '0'.

The sum total of the Sigma Drive, non-magnetic design, High Speed DC and The Zero Switching is a sound that is thunderingly massive yet ultimately precise in detail. There's a 3 dimensional aspect that will leave you breathless.

By the way, if you're not really clear on all the terms here's a quick lesson. A preamp gives you all the switching and controls like volume and bass and treble. An amplifier boosts the signal to power your speakers. A tuner receives AM and/or FM. A receiver is a combination of all three.

But, 'real' audiophiles go for separates like this integrated amp (the preamp and amplifier are together) and a tuner. You can still use the tuner in your receiver by plugging the tape out on your receiver into the aux or tuner 'in' on the Kenwood and have the best of both worlds.

Total Control

There's a stunning array of controls. Of course there are provisions for two tape decks. You can dub from deck to deck in either direction. But look at this.

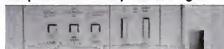
1991 Price List	
KA-900	Hi-Speed DC Amplifier



You have a direct path from each component to the 'tape out' jacks. The rotary control marked 'record out' selects what source is fed to the tape out jacks.

For listening, you'll use the push buttons just under the volume control. So, you can listen to FM or anything you like while you tape from a record or any other source. What you listen to and what you record from are totally separately controlled.

Kenwood has provided not only for two turntables but for both moving magnet and the more esoteric moving coil cartridges. There's even impedance switching on the back panel to match your cartridge.



Plus because of a new Phono preamp-lifier IC you'll experience incredible dynamic range, signal to noise to 98db and a THD on phono of an incredible .003%. All this with a phono frequency response from 20 to 20,000hz ± 0.2 db.



With the glass door closed, your preset controls are protected while you select your program source and volume.

There are bass and treble controls with turn over switches that let the bass enter at 200hz or 400hz, and the treble at 3,000hz or 6,000hz. Plus, there's tone defeat. So, the bass and treble controls act like equalizer controls to sculpt your music.



Like a parametric equalizer you can control the tone slopes.

MUCH MORE

There's a loudness compensation button and a subsonic filter that cuts 6db per octave below 18hz. The amplifier will handle two sets of speakers. And, Sigma Drive can be used for set one.

There is a stereo/mono switch and a touch fader. Once you've set the volume, a touch of the fader will bring the volume down to 0 in one second. A second touch will return it to your preset level.

Finally, all controls other than on/off volume, fader and program selecting buttons are behind the closed glass door. It looks great, keeps unwanted hands off your 'preset' controls and keeps the controls safe from dust.

AUDIO PURIST

Kenwood is of course a well known brand name. But as you'll note in the very top right corner of this amp, the Audio Purist name plate separates this unit from the standard Kenwood line.

Only the very top notch esoteric dealers carry this part of the line. Audio Purist is singled out as Kenwood's best by far.

The Audio Purist KA900 Integrated Amplifier is backed by Kenwood's standard 2 year limited warranty. It is 1.5-17.6

Suggested Retail	Dealer Cost	WT
\$520.00	\$312.00	27 lbs.

- 80 Watts Per Channel—Minimum RMS into 8 Ohms
- Exclusive SIGMA Drive
- From 20Hz to 20kHz With Less Than 0.005% Total Harmonic Distortion
- Non-Magnetic Chassis
- Zero Switching

wide, 14-3/4" deep and 4-27/32" high. TRY AUDIO PURIST SIGMA DRIVE RISK FREE

We've really tested this Integrated Amplifier. And it's the best in sound purity and control features that we've ever tested.

So, whether you've got a receiver or audiophile separates already, you're in for an awesome shock when you hear just how phenomenally better the music out of your own speakers will sound.

Try this incredible Kenwood KA900 Integrated Amplifier in your own system. If you don't hear incredibly better musical sound from the first moment, return it in its original box within 30 days for a refund.

To order your Kenwood KA900 Audio Purist 160 watt (80 thundering watts per channel RMS with 0.005% THD) Integrated Amplifier risk free with your credit card call toll free or send your check not for Kenwood's list price of \$520, but for only \$229 plus \$9 for postage and handling. Order No. 9605. CA res add 6% sales tax.



The thundering power, purity, musical detail and control of Kenwood's Audio Purist Integrated Amplifier will revolutionize the sound of your stereo system.

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10845 Vanowen St., N. Hollywood CA 91606

BITS & BYTES

By JOHN FREE



Home-computer bargains

I saw a staggering number of new computer models at the big Las Vegas consumer-electronics show recently. This year, as more firms aim at the huge home-computer market, frantic competition promises shelves full of bargains.

Atari, Inc., suggests \$899 for its new 1200XL computer (large top photo). The 1200XL's attractive, polished-metal case houses 64K (kilobytes) of RAM (random-access memory). The keyboard has 12 user-programmable keys and provides access to a European character set. There's a HELP key for simplified instructions, plus a self-diagnosis function to check circuits and wiring. Atari has also

introduced two printers: A \$299 40-column printer-plotter delivers four-color text on 4 1/4-inch paper or 16 colors for complex charts and graphs with plug-in print pens. A \$549 model prints 80-column widths at 40 characters per second. The printers and 1200XL software are compatible with other Atari computers.

Mattel Electronics unveiled its Aquarius home computer (above), a 4K-RAM model (expandable to 52K) expected to retail for about \$500. Mattel says it designed the computer and its initial programs—home management, education, entertainment, and self-improvement—for easy operation. Aquarius has BASIC built into it; another computer language, LOGO, comes in cartridge format. LOGO aids



children in developing computer-graphics programs. Peripherals include a thermal printer, cassette recorder, and an expander unit with hand controllers.

Also shown: the Timex Sinclair 2000 (above), claimed to be the first 48K personal computer under \$200 (by five cents). The 2000 features high resolution (256 by 192 pixels), eight-color graphics, and programmable sound (10 octaves). Also pictured is the \$100 Timex Sinclair 2040, a 32-column thermal printer.

An eye-catcher at Commodore's booth was a prototype portable computer similar to but smaller than the popular Osborne model [cover story, PS, March]. Commodore's upcoming portable has a five-inch color CRT. A black-and-white display might trim \$500 from the projected \$1,500 cost of the color model. The compact portable has two microprocessors, so it can run both CP/M and Commodore 64 programs. The computer has 64K of RAM and twin half-height drives for 5 1/4-inch mini floppy discs.

Quick looks

- Apple Computer has introduced its under-\$10,000 Lisa computer, built around the 16-32-bit MC68000 microprocessor (with three other microprocessors for input and output functions). Designed for easy use in offices, Lisa desk-top computers are put to work by selecting pictures of objects on a high-resolution screen with a mouse—a palm-size device used to manipulate a cursor. Also, the company introduced the Apple IIe, a 64K-RAM model with 10 more keys (63) than the Apple II Plus. Among other IIe features: an optional \$125 80-column card, self-test diagnostics, and 128K-memory option. The Apple IIe is \$1,395.

- The 1,678-page *Encyclopedia of Computer Science and Engineering*, second edition, has 550 concise articles in nine subject areas. The illustrations and authoritative entries offer excellent coverage of the field. It costs \$87.50 from New York publisher Van Nostrand Reinhold and is being offered at \$2.95 with membership in a book club (Library of Computer and Information Sciences, Riverside, N.J. 08075).

- Eight new software packages from United Microware Industries (3503 C Temple Ave., Pomona, Calif. 91768) for the Commodore VIC-20 include a word processor, record-keeping system, and graphics program for Epson printers.

- Wind/X is a \$40 utility program for the IBM personal computer from Boardroom Executive Software (Suite 240, Airport Park Plaza, 255 N. El Cielo Rd., Palm Springs, Calif. 92262) that quickly clears screens—or parts of them—of text. [E]



Phone Extortion

Let's put the screws to our phone suppliers on a terrific long range cordless phone with a novel new consumer buying tool called GREED!

It's a war. The major phone suppliers are each desperately trying to lock up big orders. And now, we've devised a plan to take advantage of their greed.

Together we can apply enough pressure to get you a super high quality cordless phone with a range up to 700' for just \$79. And, hopefully we'll make a good profit for ourselves. But, there's a problem.

TIGHTEN THE SCREWS

Before I tell you all about the great features and sound of the phone, let me explain just how we plan to deliver these phones for such an admittedly foolhardy price. You see, it's called extortion (legal definition please) and it works like this.

There are two large phone companies that are trying to get DAK's phone business. To be perfectly honest, the quality, guarantee and sound are so close that we couldn't decide between the two.

Even their prices are close. So here's what we did. We got quotes from both of them for 5,000, then for 50,000 phones.

And, here's what we decided. As you place your orders, we'll offer each of the two companies a check (cash in advance) for the number of phones we need.

The company with the lowest price of the day will get that day's order. You see, your orders give us incredible leverage.

Usually we buy just one phone from one supplier. Unfortunately once they have a contract with us, they have no incentive to lower our price. And, at our costs today, we really can't come out at only \$79.

SAFE INVESTMENT

Don't worry about your \$79. DAK is a large company. If this plan to sell 50,000 phones fizzles out, we'll still be OK. Plus, DAK doesn't even charge your credit card until after we ship.

And most important. Each phone will come to you in its factory sealed carton, and will be backed by the manufacturer's standard limited warranty.

Finally, you won't be getting a cheap

stripped down phone. We aren't dumb. We picked the phones we wanted before we got the quotes. So, nobody can make any changes to come out lowest.

And frankly we'll get 50,000 of you new customers (we have 225,000 now) to send our 68 page electronics catalog to. So, even if it does fizzle, we're sure to get another chance at you later.

A GREAT LONG RANGE PHONE

So, now let's see if this is really going to be a stripped down low quality phone. Remember, each and every feature I describe appears on both phones. And, if for some emotional reason you want to specify which phone you want, no problem, I've got a way for you to do that too.

Imagine walking from room to room in your home talking on the phone. You'll go out and get the mail, walk over to a neighbors or work in the yard or the garage.

It's a superb personal security device. You can instantly call a doctor or police from anywhere you happen to be.

And, if you are needed at home, no problem. There's a page button on the base that beeps you at the handset which then becomes a wireless intercom.

Cordless phones are a great combination of posh luxury and life saving utility.

NO INSTALLATION

If you can plug in a lamp you can install your new cordless phone. Just plug in the modular phone plug and the AC line cord, then start talking. The phone uses universal pulse dialing compatible with both rotary dial and Touch Tone® phone lines.

LOADED WITH FEATURES

Look at these features. You'll have last number redial to redial busy numbers. And mute lets you electronically put your hand over the mouthpiece for privacy.

There's both a standby/talk switch and a power off switch so that you don't have to return the handset to the base when you aren't using it.

And when you do put the handset in the

base, its heavy duty NiCad batteries recharge automatically, and the auto secure protects your base station.

If you're adjusting a TV antenna, the person at the base can talk to you using the intercom feature and any of your regular house phones. So, you'll have a cordless intercom, with a range up to 700 ft too.

The two companies that we are trying to 'extort' our low prices from are Unitech, and U.S. Tron. Even their names sound alike. Both phones are backed by a manufacturer's standard limited warranty.

TRY TOTAL PHONE FREEDOM

RISK FREE

Experience the thrill of total phone freedom as you roam throughout your home, yard or even a neighbor's house. You'll never have to 'run for the phone' again.

Try a cordless phone in your own home risk free. If you don't find the luxury of talking from wherever you are 100% enthralling, just return the phone to DAK in its original box within 30 days for a refund.

To order a long range full featured cordless phone risk free with your credit card, call toll free or send your check for the 'extorted' price of just \$79 plus \$3.50 for postage and handling. Order Number 9615. CA res add 6% sales tax.

If you have a particular love for either phone, you can have your choice for just \$89 plus \$3.50 for postage and handling. To order the U.S. Tron, use Order Number 9616. To order the Unitech, use Order Number 9617. So, you'll pay only \$79 if the choice is ours, or \$89 if it's yours.



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New gadget up the Japanese sleeve: wrist TV



TV watch has LCD screen plus time-and-date display (above). Receiver and earphones are separate components (below).



If you glance at a wrist for a time check in Japan, you may learn it's 3 to 1 in the top of the eighth

By DOUG GARR

TOKYO

The rush to build super-miniature flat-screen-TV sets perhaps reached its zenith last year when Seiko unveiled its prototype TV watch. Though impractical and inadequate, it is still something of an engineering marvel.

The wristwatch portion of the system weighs less than two ounces, and the TV screen measures $\frac{3}{4}$ by about one inch. These dimensions make the watch comfortable to wear but difficult to view. You have to squint a little to really focus on the blue-tinted monochrome image.

In a demonstration here recently, I tuned the TV watch in to the Japan World Series—between the Seibu Dragons and the Chunichi Lions. When the camera zoomed in on a player's face, reception was fine. Long

shots, however, played up the set's shortcomings: I could see the pitcher wind up and the batter's subsequent swing, but the baseball was shrunk to a dot far too tiny to see. (The Japanese are aware that the TV watch is more appropriate for displaying information—weather forecasts, train and plane timetables, etc.—than it is for entertainment.)

The receiver is housed in a cassette-player-size unit, which picks up VHF and UHF channels plus stereo-FM-radio signals. You simply plug the receiver into a jack at the top of the watch, switch the mode button on the receiver to TV SET, and put on the lightweight earphones. Sound quality is fine. To tune the set, you move a dial on the receiver, a somewhat difficult and annoying feature used on other tiny TVs. Seiko says it will switch to push-button tuning before marketing the watch.

Research bonus

The screen itself was developed as a sort of byproduct of Seiko's watch-display research. Unlike conventional TV screens, which create images by using an electron-beam, phosphor-screen, cathode-ray tube (CRT), the Seiko produces images with liquid crystals, the organic chemicals commonly used in displays for calculators, digital watches, and portable games. Flat-screen LCD TV has been around in prototype units for years [PS, March '75; June '81], but Seiko will likely be among the first to sell such a set. Company engineers won't reveal exactly how the display works, but the technical data say there are 31,920 liquid-crystal picture elements attached to a silicon wafer. These form the changing images on the screen as voltages applied to a large-scale-integrated-circuit substrate switch the individual elements, making them transparent or opaque as required. Like other LCDs, the picture looks brightest when viewed in good light. The display is supposed to last seven years. The set operates on just two AA alkaline batteries, which are said to provide approximately five hours of viewing.

As a watch, incidentally, the Seiko operates in four modes: as a digital timepiece (showing hour, minute, and second), calendar, alarm, and stopwatch with lap timer.

Seiko says the TV watch will be available in Japan some time in 1983 for \$400 or less. Since Japan and the U.S. have similar broadcasting systems, we are a likely foreign market. But don't expect to be watching the World Series on your wrist for at least a few years. [E]



The sleek handset can be placed up or down.

Bedside Big Mouth

Now you can reach out to the world from the comfort of your bed with this elegant new electronic clock radio, telephone and speaker phone.

You're lying in bed. And, you are discussing the day's events with your mate. The lights are out, you're relaxed and your hands are at your sides.

So what's so new? Well for one thing, your mate is out of town and the two of you are talking on the latest in hands free speaker phones. What's more, if the two of you were in bed together, you both (or your whole family for that matter) could talk to anyone on the phone simultaneously.

Of course you can pick up the decorator designed phone handset with its long coiled cord, and talk or make calls as you would with your regular telephone. But with this new phone, you'll have all the new telephone advances rolled into one.

And best of all, you won't have to pay the phone company's monthly rental charges for their dumb phones ever again. Just plug in the standard modular plug and the AC line cord and you're ready to go.

You'll have universal push button dialing that gives you the convenience of push buttons anywhere and works on your current phone line and your own number.

A last number redial key redials busy numbers with the touch of a button. And, you'll really enjoy the delightful chirping electronic ring that won't send you into shock if it sounds when you are asleep.

If you want momentary privacy from the person you're talking to, a mute key lets you have it. It's like electronically putting your hand over the mouthpiece.

The sound quality is nothing short of incredible. An electret condenser mike lets you be heard loud and clear at the other end, whether you're using the handset or the hands free speaker phone.

When you use the handset, you hear the other person through a high quality transducer like you'd find in fine headphones. With the speaker phone, you'll hear fab-

ulous sound through the Hi Fidelity speaker used for the AM/FM radio.

AND WHAT A CLOCK RADIO

If you're impressed with this telephone system (I hope you are) wait till you find out about the timing conveniences and sound quality of this electronic clock radio.

First the controls. The large green LED display with high/low brightness switch, is extremely easy to read. You won't have to worry about losing the time if there's a power failure once you install the standard 9V battery (included) for protection.

You'll have fast and slow set for both the regular and alarm times. And, once you've set the alarm, you can choose to be awakened by your favorite radio station or an electronic chirp alarm. If you aren't quite ready to get up, just tap the handy snooze button for a few minutes of extra sleep.

And since getting up is no fun, this radio will also help put you to sleep. A touch of the sleep button will give you up to an hour of your favorite radio station to relax you. The radio will then shut itself off and wait to perform its next programmed task.

GREAT SOUND SAYS IT ALL

It doesn't take many features to beat the phone company's phones. But, there are lots of regular clock radios.

Once you hear the sound of these fine sensitive radio receivers, you'll be sold on the sound as well as the phones.

This FM radio really pulls in the stations. And the full range speaker has a very pleasing and full rich sound.

Of course, with the touch of a switch you can also tune in your favorite AM stations too. You can keep up with the latest news or your choice of music on AM.

This all new electronic clock radio telephone brings a really elegant look to your bedroom, office, den or kitchen. What you can't see in our pictures is the elegant

sound you'll enjoy for years to come.

The sound quality shouldn't really be a surprise. You see, it's made by Unitech, the enormous personal stereo company. In the personal stereo business, sound quality is everything. And it's backed by their standard limited warranty.

TRY THE BEDSIDE BIG MOUTH RISK FREE

Be prepared for a shock. If you haven't tried any of the new electronic phones you're in for a pleasant surprise. And, for that matter if you haven't bought a new clock radio for a few years you're going to be pleasantly surprised too.

Try this all new Electronic Clock Radio Telephone risk free in your own bedroom. If you aren't 100% satisfied, simply return it to DAK within 30 days for a refund.

To order your all new Unitech Bedside Big Mouth (our name for it), Electronic AM/FM Digital Clock Radio Telephone, with both handset and speaker phones risk free with your credit card, call toll free.

Or send your check not for the up to \$129 to \$159 price tag we've seen on other telephone clock radios without the speaker phone, but send the incredibly low price of just \$68 (\$5.50 P&H) Order No. 9607. CA res add 6% tax.

Now you can replace the phone company's dumb phone and add an exciting elegant clock radio with fabulous sound to turn your bedroom into an entertainment and communications center.



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TOLL-FREE 1-800-423-2636
If busy, after hours, on weekends or in CA
CALL TOLL-FREE . . . 1-800-228-1234
10845 Vanowen St., N. Hollywood CA 91605



The \$7 Push Button Phone

Plug in and start pushing. Now you can have highly automated phones with no monthly service charges for just \$7 each. But, there's a catch.

Send back your dumb phones. Now instead of paying monthly service charges you can have push button dialing, last number redial, mute, and ringer off.

You can forget big clunky phones. You can also forget dials. This phone works perfectly whether you now have rotary or push button phones.

Now for just \$7 you'll have the latest technology at a price that'll let you have a phone in every room in your home. But, don't forget there's a catch.

NOTHING TO INSTALL

Simply plug this phone into any standard modular phone jack and start talking. If you don't already have jacks, call your phone company.

They may even put them in free for

quality speaker instead of the old diaphragm 'thing' that's been in phones for 20 years. Even the electronic ring is new.

But, the nicest part of all are the push buttons. Once you've started using buttons you'll hate dialing the old way.

With this phone you can push the buttons as fast as you want. Then the phone sends out pulses on your line that work with virtually any phone system.

So this phone works anywhere. You can unplug it and move it from room to room or house to house in seconds.

The phone automatically hangs up when you set it down or you can push its 'hang up' button. It comes complete with an 8 foot cord, coiled at the phone end, and a limited warranty.

We challenge you to compare the frequency response, dynamic range and signal to noise ratio of our new Gold Label MLX to Maxell UDXL or TDK SA. If they win, we'll not only give you back your money, we'll give you a free gift for your trouble. And, DAK's come with a deluxe hard plastic box, index insert card and a limited 1 year warranty.

WHY, YOU MAY BE ASKING?

You're very valuable to us in the form of future business. Over 150,000 customers have responded to bonuses like this. We find most of you keep buying once you've tried our cassettes and our prices; and that's a gamble worth taking.

NOT A BAD CATCH

DAK manufactures a cassette with no problems and great sound. We've been hot on the heels of the frequency responses of Maxell and TDK. The tape we made last year had a great frequency response up to 14,000hz.

Now our new Gold Label MLX is second to none. We have a frequency response to 19,500hz and we'll go head to head against any tape on the market.

TRY NEW DAK MLX90 CASSETTES

RISK FREE

To get the automated phone for just \$7, try 10 MLX high energy cassettes. If you aren't 100% satisfied, return only 9 of the 10 cassettes and the phone in its original box within 30 days for a refund. The 10th cassette is a gift for your time.

To order your 10 Gold Label DAK MLX 90 minute cassettes and get the automated phone for only \$7 with your credit card, call the DAK toll free hot line or send your check for only \$24.90 for the tapes, plus \$7 for the phone and \$3 for postage and handling for each group. Order No. 9416. CA res add 6%.

An automated Phone for \$7 and DAK's new improved MLX. Time to stock up.



It's built more like a HiFi than a telephone. Modern electronics have finally come to phones.

you. Due to the recent Supreme Court ruling, soon they'll probably be selling you your own phones anyway. And, at worst, there's just a small one time fee.

LAST NUMBER REDIAL PLUS

It's really neat. If you call a number and it's busy this phone will automatically redial the number for you each time you touch 'redial'. There's no need to keep dialing over and over again.

When you need to speak privately to someone with you, you don't have to cover the mouth piece. Just press the mute button and the person on the line will be cut off for privacy.

When you want to take a nap, just switch the ring off and the phone won't ring. There's never a need to take your phone off the hook again.

The quality is great. A high quality condenser microphone lets the person you talk to hear you loud and clear.

And you hear them through a high

THE CATCH

Frankly we are losing our shirts on the automated phone, but we're looking for audiophiles who use audio cassettes.

If you buy top name TDK and Maxell cassettes, you probably pay \$3.50 to \$4.50 each for a 90 minute cassette.

We want you to try DAK's new Gold Label MLX ultra high energy, normal bias cassettes. Not at \$4.50 or even at \$3.50 each, but at a factory direct price of just \$2.49 for a 90 minute cassette.



DAK INDUSTRIES INCORPORATED

Call TOLL-FREE (800) 423-2636
In California Call (213) 984-1559
10845 Vanowen St., North Hollywood, CA 91605



Here's the super horn tweeter that BSR left out. We'll send it along with your speaker. It fits right in where the 3" tweeter is now.

Thunder Lizard Mistake

If you're willing to spend 5 minutes with a screwdriver, you can cash in on BSR's mistake and experience precise thundering bass and breathhtakingly clear highs.

It was a mistake. Somebody goofed and put the wrong tweeter in this top of the line BSR 15" 3 way speaker system. The 3" tweeter they put in is normally used only in BSR's smaller 10" and 12" systems.

But don't worry. If you've got a screwdriver and 5 minutes you can turn these Thunder Lizards back into BSR's awesome top of the line 15" speaker systems, with thundering earthshaking bass and breath-takingly brilliant crystal clear highs.

THUNDER LIZARDS

BSR built 3500 of these speakers. Their salesman referred to them as Thunder Lizards because the 15" acoustic suspension bass driver is so powerfully dramatic that it can literally recreate the power of an earthquake or explosion in your living room.

Unfortunately, without the brilliant and powerful exponential horn tweeter, the bass simply overwhelms the high end and so the name Thunder Lizard was born.

YOU WIN

Because the speaker systems are factory sealed, BSR didn't want to open them and install the correct tweeter. Plus to a company the size of BSR, 3500 speakers just aren't enough to worry about.

So because of BSR's mistake, you can save a fortune. DAK bought all 3500 of the speakers. Plus, BSR sold us the exponential horn tweeters that were supposed to be put in originally.

So, here's the deal. We'll ship you the factory sealed BSR 15" 3 way speaker system with the wrong tweeter, and we'll ship

the exponential horn tweeter separately.

All you do is unscrew 4 screws and pop out the 3" tweeter. Then, just pop in the exponential horn in the same hole. There's no soldering because push-on lugs are used, and even the screws fit exactly. You even get to keep the 3" tweeter.

WHAT SOUND

The kaleidoscopic panorama of sound from this speaker is nothing short of incredible. You're in for an earthshaking, bone jarring musical experience.

The exponential horn tweeter gives you startlingly dramatic highs to 20,000hz. A brilliance control lets you decide just how powerful you want the highs to be.

The midrange is velvet smooth. It's reproduced by a special 4" ferro-fluid cooled midrange driver. A presence control lets you contour the midrange to your taste.

Finally, the bass all the way down to 20hz is reproduced with thundering accuracy by the pride of the BSR line, a 15" acoustic suspension bass driver.

The beautifully crafted wood-grain appearance cabinet is 29" tall, 18" wide and 10-1/2" deep. And, it comes with a beautiful removable cloth speaker grill.

BSR backs this system with a 2 year limited warranty, and speaking of protection, the tweeter is fuse protected. The system can handle 180 watts peak, 90 watts continuous and requires 15 watts.

THUNDER LIZARDS NO MORE RISK FREE

Soft listening will give you a fullness and

realism of sound not possible with conventional 10" and 12" speaker systems.

And wait till you (and your neighbors) hear the thundering realism of high volume listening with these incredibly pure audiophile speaker systems.

Normally only the most sophisticated audiophile can afford the ultimate, a 15" 3 way speaker system. But now due to BSR's error, everyone can experience the incredible realism of a truly great speaker.

If for any reason you're not 100% overwhelmed by these speaker systems, simply return them to DAK in their original boxes within 30 days for a refund.

To order your BSR top of the line 15" 3 way loudspeaker system with the exponential horn tweeter risk free with your credit card, call toll free, or send a check not for the suggested retail price of \$199 each, but for only \$119 each, plus \$12.50 each for postage and handling. Order No. 9614. CA res add 6% sales tax.

Now, if you'll spend just 5 minutes with a screwdriver you'll experience dramatic earthshaking musical sound that's so startlingly alive, it'll send shivers through your body for years to come.



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PRICE BREAKTHROUGH!



Epicurean's Phone

Now you can have the look of fine furniture, the electronics of a fine stereo, plus a hands free 2 way duplex intercom, all at DAK's incredible breakthrough price.

It's sad. It seems there just aren't as many rich people as there used to be. We all seem to be working harder and spending our time looking for discount sales.

Well, American Telecommunications, (ATC) the people who make the Genie™, Snoopy® and the Mickey Mouse® phones for the telephone company have made a rich man's phone called the Deco-Tel® cordless chest phone.

This is no ordinary cordless phone. Its electronics and sound quality rival a fine stereo system. And it has a 2 way intercom that actually makes the base a hands free duplex intercom.

And, finally you can't mistake the quality. From its classically styled carved chest that blends into the most lavish home or office, to the look and substantial feel of the handset. This cordless chest phone is very simply, the best.

we have in stock for immediate delivery) you don't have to be rich to own one.

Thing two: You can install this phone just about anywhere. All you need is a standard modular phone jack and an AC plug. The phone uses your own phone number and normal phone line with no changes needed.

SUPERB QUALITY ELECTRONICS

Imagine walking around the house or yard without having to 'run for the phone' if it rings. Imagine that you're at a neighbors, or walking the dog around the block and you want your spouse to join you.



With this phone, not only can you make or receive phone calls, you can be called from home if you're needed. And look at this, with the push of a button, you can call home if you need help, information or if you just get lonely.

Think of the convenience for your wife, of being able to talk on the phone while keeping track of the children. She can check on them in the yard or down the street. And she can instantly call a doctor or police from wherever she is.

You can be working in the yard or garage and simply buzz your wife (spouse) when you want a beer, (or champagne with this phone). If you're on the roof or a ladder and you need a tool, no problem.

You see, with this phone, you can do more than make and receive phone calls. You can also page and talk directly to or receive calls directly from the beautifully carved hands free intercom chest base.

If you want to call the base, just switch to intercom on the handset and the base will ring. If someone wants to call you, they touch the base's intercom button.



A full duplex intercom complete with a microphone and speaker is built into the base. Anyone at the base can move around the room or lie in bed while talking to you. There's even an intercom volume control.

So now, you'll make and receive phone calls in the garden, by the pool, or forgive the example, but any number of locations in the bathroom.

SO WHY IS IT BETTER

This phone is a marvel of space age design and circuitry. Besides its obvious elegant good looks, its superior sound quality and the duplex 2 way hands free intercom, it's loaded with the latest state of the art circuitry.



INSTALLS ANYWHERE

Before I tell you about all this phone's incredible features, you need to know two things. Thing One: Because of a large cash purchase of 2000 of these phones, (which



Power saving circuitry and heavy duty NiCad batteries give you up to 50 hours of standby or 8 hours of actual conversation between charges. Just place the handset back in the chest for automatic recharging. And auto-secure takes over whenever the handset is in the chest.

This phone is also great for the office. It's a beautiful and useful addition to the executive suite. You can be reached wherever you are in an area up to 12 football fields, that's up to a 600 or 700 ft range.



In a factory, in shipping, in a store, or in a colleague's office, you can be reached by your secretary, or by any incoming calls. Plus if you need something, you can reach your secretary or make outside calls.

You can add this phone to any multiline office system by just using our Electronic Phone Octopus. On single line systems, just plug it in like you would at home.



From last number redial and LEDs that show all the functions, to an extra jack to plug in another phone, this phone is loaded. It's universal modular plug and push button pulse output work on both rotary dial and Touch Tone® phone lines.

A SECURE INVESTMENT

American Telecommunications is an enormous company. Just visit your local phone company store to see the dozens of phones they make for phone companies.

DAK has made an incredible buy on these 2000 phones. You'll find cordless chest phones selling up to \$249. This phone is UL listed, FCC approved and you are protected by American Telecommunication's standard limited warranty.



LAVISH TELECOMMUNICATIONS RISK FREE

If you have a lavish home or office, or if you plan to have one in the future, this phone will fit right in. If you demand only the best from your stereo system, now you won't be disappointed with the sound quality of your new cordless telephone.

Try the ultimate cordless chest phone risk free in your own home or office. If you aren't 100% impressed for any reason, simply return it in its original box within 30 days to DAK for a courteous refund.

To order your incomparable American Telecommunication's Deco-Tel® cordless chest phone risk free with your credit card, call toll free or send your check for the incredibly low discount price of just \$169 (\$5 P&H) Order Number 9606.

As DAK's president and chief tester, I can safely say that after testing dozens of cordless phones by many manufacturers, this is without question the best looking, best feeling, best sounding I've tested.



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HOUSEPOWER CLINIC

By EVAN POWELL

A recent news release from the Department of Energy was hardly news: Household energy use in the U.S. dropped 17 percent from 1978 to 1980, it said, while home-heating and electricity costs soared by 27 percent during the same period. What can you do about it? Plenty. Though the cost of electricity in general is up, you still may be paying more for it than you have to because you aren't taking advantage of special rate structures.

One of these is a special rate for energy-efficient homes—if you've insulated and sealed yours thoroughly, you may qualify. Most power companies will inspect your home and advise you of any requirements for bringing the house up to its standards.

Other special rates include time of day, load control, and demand rates, which are being phased in all across the country though few consumers are taking advantage of them. National figures are not available, but a local official says that fewer than five percent of those eligible for such rates have signed up in my area.

Consider what they're missing: Choosing the load-control service requires that you install load-control devices, which are furnished free by the power company and installed by an independent contractor for \$35 (or you can do it yourself using directions furnished). This allows the power company to disconnect your water heater or air conditioner for a limited time at certain periods of peak demand by sending a signal over the line. In most cases, you never notice because the power isn't off long enough to let the water cool or the house warm up. The savings? Using an 80-gallon water heater and three-ton (36,000 Btu) air conditioner (rates depend upon sizes involved) in my area, you'd get a \$28 credit during summer months and \$4 in the winter.

The amount of savings varies in every locality, but it's well worth a phone call to your utility to see if you can qualify.

Q&A Golden-age parts

I have an ancient Crosley Shelvador refrigerator (model SC9-1) that was handed down from my parents and is still in excellent running condition except for one thing: The door gasket has completely deteriorated. I'm sure that replacement parts are unavailable, but I would like to keep it running. Will stick-on foam weatherstripping, such as that sold for exterior doors, work if I adjust the door to compensate for the reduced thickness, or would I be wasting my time?

Bill Shore, St. Louis, Mo.

Surprise! Just go to your local appliance-parts distributor and tell him you want to order Gemline part No. CR-83; you'll get an exact replacement. Gem Products does an excellent job of stocking and cataloging functional parts for many older appliances, a real boon for those trying to keep appliances running through old age. Whether your problem is with a Coolerator, Deep Freeze, Bradford, Marquette, or many other almost-forgotten brands, don't give up hope—they just may have what you need.

Kenmore-Whirlpool bearings

A 1977 article in PS gave details about a bearing kit to remedy worn spin-tube bearings in Whirlpool and Kenmore washers. I ordered one, but my letter was returned. Is there another source?

Paul Feorene, Fairmont, W.Va.

Some appliance-parts distributors stock the kit, called the BK-1. It's also available from Bricktown Engineering & Development Corp., 440 Bella Vista Rd., Brick, N.J. 08723. I consider the BK-1 a permanent repair if the rest of the gear case and clutch are in good condition—and a suitable temporary repair otherwise.

Paint-on vapor barrier

I live in a cold northern climate where most homes were built in the early 1900s and do not have insulation in the wall-stud cavities. Blown-in cellulose insulation is a popular way of insulating, but the local contractors and government agencies doing most of the work neither install nor mention the need for any type of vapor barrier on the heated side of the wall (which, in most cases, is plaster-covered lath).

Is a vapor barrier needed for this type of installation, and if so, what kind? Would something like Glidden's Insul-Aid vapor-barrier paint be the answer?

Jeff Musselman, Laurium, Mich.

It is indeed the answer. If your wall has several heavy coats of oil-base paint, it could have enough protection—but you can't be sure. These paint-on vapor barriers exceed accepted requirements, and I recommend them for your problem.

Derating a gas furnace

I have a Century gas furnace (model GH185) that I want to derate for greater efficiency. I wrote to the company that sells it, and it replied that the furnace could be derated 25 percent with the proper smaller jets. I then asked a local

heating firm to make the change, but after almost two years and several letters the company says it hasn't been able to get the jets. Can I get them from another source?

Robert Westfall, Kankakee, Ill.

Most orifices, or jets as you call them, are standardized. Check with your gas company; it can tell you the drill size for the proper orifice opening to achieve the Btu rating you desire, and it may even supply and install them for you. If all else fails, a good machine shop should be able to brood shut the opening in the existing orifices, then drill them out to the size you desire.

Cheap protection

My air-conditioning installer told me to always turn the system off when we have a thunderstorm—as we frequently do in our area—since it isn't good for the system to stop and restart quickly. That's probably good advice but almost impossible to follow since no one is home during the day. Is this really important?

Mary Jackson, Atlanta, Ga.

Very! Short cycling, whether it's caused by a power interruption during a storm or by turning the thermostat up and back down without a waiting period of several minutes, requires the compressor to attempt a start while high pressures are still in the system. All air-conditioning systems have special current and temperature-sensing controls to shut the compressor off under this load, but prolonged end repeated cycling can destroy the control windings—and repair is expensive.

Air-conditioning-parts suppliers carry a solid-state "time delay on break" relay to eliminate this problem. Well worth the \$20 to \$25 cost, it installs in the low-voltage thermostat circuit and simply interrupts the circuit for three to five minutes in the event of a power loss.

Renewing the barbecue

Last spring I repainted my gas barbecue grill with flat-black paint, and soon after it looked worse than before: The paint peeled and discolored. Should I have used a primer? The grill's base metal is aluminum.

Roy Jenkins, Kansas City, Mo.

No primer is necessary, but the proper heat-resistant paint and good surface preparation are. Start by removing the racks and grids, then wire-brush all surfaces to be painted—remove baked-on food and loose, deteriorated coats of paint. Remove all traces of grease by using an oven cleaner or strong detergent solution. Then flush the grill thoroughly with water and allow it to dry. Finally, apply one or two coats of heat-resistant paint, available at most hardware stores.

Got a home-equipment problem?

Write to Evan Powell/Housepower, Chestnut Mountain, Route 1, Box 322A, Travelers Rest, S.C. 29690, giving appliance make and model number. Unpublished questions cannot be answered by mail.

smooth

Ask a Charter drinker why Charter is his bourbon, you always get the same answer: "smooth." With Charter there's no bourbon "bite" or even a hint of harshness. It's all mellow and easy to drink, easy to stay with. No matter which Charter you prefer, Charter always treats you smoothly.

CHARTER
Aged until it's all smoothed out.



TWO WAYS TO CUT YOUR FUEL CONSUMPTION BY ONE-THIRD



- Turn down thermostat 10-15 degrees.
- Buy room heater.
- Achieve reduction in fuel consumption by one-third.
- Congregate around room heater.



- Install high-efficiency gas heating system.
- Keep thermostat at normal level.
- Cut fuel consumption by up to one-third.
- Enjoy whole-house comfort ...for years to come.

SIX WAYS TO SAVE AND STAY COMFORTABLE

These fuel-efficient gas heating systems are designed to extract more heat from the gas they burn. Which means they'll keep your whole house comfortable while using a lot less energy doing it. They make gas—always your best energy buy—an even better value today, and for the

years to come.

And here's another comforting thought: Recent Department of Energy studies project that by 1990 the price of natural gas will be 70% of the price of home heating oil and only 42% of the price of electricity.



RECUPERATIVE GAS FURNACE

Arkla's patented recuperative heating system features a stainless steel heat exchanger, electronic spark ignition and built-in power vent. Downflow and Upflow models to 120,000 Btu/hr. Installs in space of conventional furnace. Sidewall venting is possible, permitting easy conversion from electric heating. Limited 20-year heat exchanger warranty.



HIGH-EFFICIENCY GAS FURNACES

offer you what you'd expect from the world's largest gas furnace manufacturer: quality, dependability, and energy efficiency balanced with purchase price. Send the postcard for our free energy-efficiency "comparator." It takes the guesswork out of calculating "years to payback."



SUPER FURNACE

Enjoy heat throughout your home with Carrier's new Super Furnace. Quality built for quiet and efficient operation, it features advanced burner system and computer-designed heat exchanger, plus energy-saving automatic spark ignition. Vertical or horizontal models fit easily in old furnace space. Electronic control center simplifies installation and servicing.



PULSE™ GAS FURNACE

The Lennox Pulse is unlike any other gas furnace in the world, thanks to a breakthrough in heating technology. This uniquely designed furnace is so reliable that the heating assembly has a 20-year limited warranty. And no other gas furnace costs less to operate. The Lennox Pulse Furnace is high efficiency at its money-saving best.



ULTRA™ FURNACE

The all-new Magic Chef Ultra gas furnace has a specially designed stainless steel heat exchanger for maximum heat transfer. Exclusive self-cleaning, non-linting power burner maintains high efficiency. High-capacity, dynamically balanced blower moves air quietly through whole house. Built for years of trouble-free service.



VHE GAS BOILER

Weil-McLain's VHE—Very High Efficiency—Gas Boiler features induced draft combustion, heat extractor, pilotless ignition and other energy-saving features that greatly reduce gas usage. Cast-iron construction for long life. Vents through sidewall or roof. Backed by a 20-year limited warranty and a 100-year reputation for quality.

For more information on these high-efficiency gas heating systems, send the reply card today. No postage required.

Gas: The future belongs to the efficient.

© 1983 American Gas Association

If you expect a truck to quickly pay for itself in work done and fuel saved, you've come to the place where somebody did it right.

For a great price: \$5,998,* the new 1983 Toyota Standard Bed Truck delivers the goods. In the bed. Under the hood. And in driving comfort, too.

Out back it handles 1400 pounds of goods.** With ease.

In performance, you get a dependable 24 liter SOHC engine — the largest engine in its class. With a hefty 100*** horsepower rating and fuel efficiency that's even more impressive: 32

Estimated Highway MPG. (26) EPA Estimated MPG.**** Add that to the electronic ignition system, 4-speed synchromesh transmission and power-assisted brakes, and you've got the goods to make the delivery easy. Normal maintenance an infrequent and simple affair. And durability something you can bank on.

The good news in driving comfort is a full bench seat with room for three. Steering-column mounted controls are also designed for easy operation.

The new 1983 Toyota Standard Bed Truck. Once you

OH WHAT A FEELING! TOYOTA

check it out, its price will convince you to drive it out.

* Manufacturer's suggested retail price. Dealer's actual retail price may vary. Price does not include tax, license, transportation, optional or regionally required equipment.

** Including occupants, equipment and cargo.

*** 96 HP in the State of California.

**** Remember: Compare this estimate to the EPA "Estimated MPG" of other gasoline-powered trucks with manual transmission. You may get different mileage depending on how fast you drive, weather conditions and trip length. Actual highway mileage will probably be less than the "Highway Estimate"

BUCKLE UP—IT'S A GOOD FEELING!

THE LOW-PRICED TRUCK THAT MEETS HIGH EXPECTATIONS.



\$5998!

Sporty small sedans

Now economy cars are performers, too

By **JIM DUNNE**
and **JACK KEEBLER**

PHOTOGRAPHS BY GREG SHARKO

A new wrinkle in economy cars is the return to performance and sports handling. For car buyers who want something more exciting than 30 miles per gallon, Detroit now offers hotter engines, firmer suspensions, and sports-car styling touches on cars that are primarily fuel-economy leaders.

PS collected four examples of this new breed for our tests at Bridgehampton Race Circuit in New York.

Four pocket rockets (clockwise, upper left): Buick Skyhawk T Type, Dodge Shelby Charger, VW Rabbit GTI, Ford Escort GT.

They were: Volkswagen Rabbit GTI, Dodge Shelby Charger, Ford Escort GT, and Buick Skyhawk T Type. We found a wide variation in what auto makers think a performance car should be. Two of these cars performed far better than their standard-edition counterparts, but the other two we tested turned out to be big disappointments.

In acceleration and all-around power, the Rabbit GTI and Shelby Charger stand out. Despite the burden of an extra passenger and about 30 pounds of test equipment, each aver-

PS ratings— test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Rabbit GTI	Shelby Charger	Escort GT	Skyhawk T Type
Acceleration	5	5	3	3
Braking	3	1	2	2
Handling	4	5	5	3
Maneuverability	5	5	5	5
Quietness	1	1	2	2
Roominess	3	3	3	3
Vision	4	4	5	5
Entry/exit ease	3	4	3	4
EPA economy	4	5	5	5
Ride comfort*	2	1	2	2

*Authors' opinion

aged zero-to-60-mph times in the sub-13-second range. That kind of performance is on a par with many low-priced sports cars.

These small front drives will spin wheels from a standing start and are equipped with throaty exhaust sys-

Continued





Shelby Charger was a top performer on high-speed handling grid. Wide, low-profile radials provided plenty of grip.



Rabbit GTI's performance-tuned suspension was a stable platform for fast changes in direction, even at 75+ mph.

PS car test & driving report

tems that reminded us of the lightly muscled, small V8s of the past. We don't measure top speed in our tests, but GTI and Charger will put out power evenly through the low-speed driving ranges and still have lots of punch left at 60 and 70 mph.

There was one area, however, where none of the performers measured up—braking. If you expect these models to stop quicker than the standard versions, you'll be disappointed. Surprisingly, most of the standard models of these sportsters stopped in comparable or even shorter distances. For example, Escort GT stopped in 174 ft., while the standard Escort (PS, Jan.) did it in 173. Rabbit GTI's distance was 153 ft., Rabbit diesel (PS, Jan.), 157; Skyhawk T Type, 185 ft., Pontiac 2000 (PS, Jan.), 148 (both J-cars); Shelby Charger, 201 ft., Charger 2.2 (PS, Sept. '81), 178. These results are especially confusing since all the performance cars sport large, ventilated front-disc brakes.

Volkswagen Rabbit GTI

The Rabbit GTI handles its performance role best. You know you're in for a treat right from the start. Steering is firm, even heavy, compared with power-assisted sedans. And there is no jiggle or feedback in the four-spoke wheel when the front tires are digging out during hard acceleration. In the high-speed-handling and low-speed-maneuverability tests, the hatchback GTI feels solid and controllable and reacts predictably. A slight amount of understeer is built into the chassis when the handling limit is reached.

The GTI's ride is firmer than the standard Rabbit's and gives a sports-car feel. The highly contoured front seats rival the comfort and holding

power of more-expensive sports-car types.

GTI's 1.8-liter (109 cu. in.) high-output engine (not available in other Rabbit models) is the key to its performance. Teamed with a close-ratio five-speed-manual transmission, it gives outstanding performance for its displacement. Other standard equipment includes front and rear stabilizer bars, alloy wheels with performance radial tires, tuned suspension, and a special exhaust system that improves exhaust-gas flow while emitting a throatier sound. Yet there is little sacrifice in ride comfort, and noise levels are close to those of the standard Rabbit.

Dodge Shelby Charger

Developed by long-time race-car designer Carroll Shelby, this adaptation of the two-door Omni returns Dodge to the performance race once more, but in a package far different from the 440-cu.-in.-V8 earth shakers of the past.

More power from the revised 2.2-liter Chrysler four-cylinder engine makes Shelby the fastest car in Chrysler's lineup. The quick steering has a solid, heavy feel that results from its fast ratio. Fortunately, power assist keeps the turning force manageable, even when parking.

Styling changes on the outside are striking. Shelby's aerodynamic additions provide more than flair. The front air dam is highly efficient in keeping chassis-grabbing wind from under the car.

The attractive exterior styling touches are matched inside the car, with the same gray-and-blue color scheme in seats and soft trim. As in Rabbit GTI, the cargo-carrying benefits of the hatchback are a plus.

EPA fuel mileage (mpg)

	Rabbit GTI	Shelby Charger	Escort GT	Skyhawk T Type
Highway	38	46	44	46
City	26	28	29	28
Calif. city	29	28	29	28

PS fuel-mileage tests (steady-state mpg)

35 mph	*	44.5	40.8	40.9
55 mph	*	33.4	35	32.4

*Not tested

Shelby has problems with passenger comfort and chassis feel. Large, bucket-type front seats are intended to hug the torso, but we found that they gave inadequate lateral support for really spirited driving. And the center armrest is too far away to furnish much side support, either.

More important, the overall feel of the chassis is loose. The rubbery shift detents of the transmission, the tendency of the front end to lose traction on damp pavement, and a willowy feel of flexing in the body stand out in contrast to the taut handling feel of the competition.

One awkward feature is a steering-wheel position that feels higher than that in the four-door version. The reason? The seat cushion is set lower in the sleek two-door models. This allows adequate head room despite the 2.3-inch-lower roof. Unfortunately, the steering wheel has been left at the four-door position.

Ford Escort GT

Escort GT is an attempt to make the same gains in the economy-car

For specs and test results, turn page
[Text continues on page 50]

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1 How much experience have you had in woodworking, home repair and/or home maintenance?

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- (C) Quite a bit of experience

2 Which phrase best describes your workshop?

- (A) A selection of hand tools and portable power tools
- (B) A table saw or radial arm saw, along with hand tools and portable power tools
- (C) A good selection of stationary and portable power tools, along with hand tools

3 How involved do you want to become with woodworking, home repair and/or home maintenance?

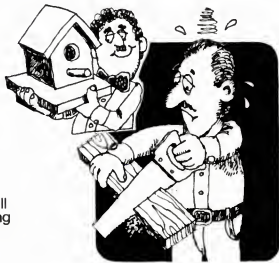
- (A) Not very involved
- (B) Moderately involved
- (C) Heavily involved

4 What's the likelihood that you'll buy some kind of woodworking tools within the next year?

- (A) Not likely
- (B) Somewhat likely
- (C) Highly likely

5 Which best describes you?

- (A) I do home repairs and maintenance only when it can't be done any other way
- (B) I do some woodworking and a variety of home repairs and maintenance
- (C) I'm primarily interested in fine craftsmanship woodworking



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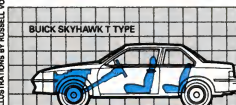
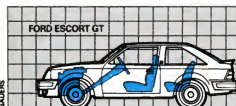
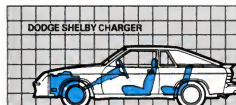
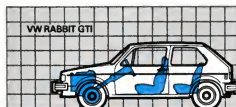
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Volkswagen Rabbit GTI, Dodge Shelby Charger, Ford Escort GT, and Buick Skyhawk T Type—dimensions, specs, and test results



Small size, low weight, and front drive enabled all of the vehicles to make impressive runs through the low- and high-speed handling tests.

PS serviceability ratings

How easy is it to service these cars? To give you an approximation of how difficult it is for a typical person to perform various service operations, we examine each test vehicle. The numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty; 4, easy; 5, very easy.

	Rabbit GTI	Shelby Charger	Escort GT	Skyhawk T Type
Checking fluid levels				
Battery	5	5	5	5
Master cylinder	5	5	5	5
Windshield washer	5	5	5	5
Engine oil	5	5	5	5
Coolant	5	5	4	4
Checking the engine				
Spark plugs	5	5	5	5
Distributor	5	5	5	5
Oil filter	5	4	4	5
Oil fill	5	4	4	5
Replacing hoses				
Upper radiator hose	5	5	5	5
Lower radiator hose	4	5	4	4
Heater hoses	3	5	3	2
Changing bulbs				
Headlights	5	4	5	4
Tailights	4	5	5	4
Front running lights	4	5	3	5
Front parking lights	4	5	3	5
Front directionals	4	5	5	3
Rear directionals	5	1	5	4
Rear running lights	5	1	none	4
Checking hoses				
Spare-tire accessibility	5	5	4	4
Changing belts	4	4	3	4

DIMENSIONS (inches)	VW Rabbit GTI	Dodge Shelby Charger	Ford Escort GT	Buick Skyhawk T Type
Wheelbase	94.5	96.6	94.2	101.2
Overall length	173.7	155.3	163.9	174.3
Overall height	55.5	49.9	53.3	51.7
Overall width	63.4	66.7	57.4	65.0
Track, F/R	54.7/53.1	56.1/55.6	54.7/56	55.4/55.2
Ground clearance	4.5	5.0	4.5	4.5
Front head room	36.0	37.2	38.1	37.7
Front hip room	46.0	52.6	52.2	52.8
Front leg room	40.0	42.5	41.5	42.1
Rear head room	35.0	34.4	37.4	36.5
Rear hip room	46.0	46.1	44.1	49.8
Rear leg room (min.)	36.0	28.7	35.0	31.2
Rear knee room (min.)	1.0	-3.3	1.1	1.8
Coupe distance	31.0	26.3	29.4	28.1

SPECIFICATIONS	VW Rabbit GTI	Dodge Shelby Charger	Ford Escort GT	Buick Skyhawk T Type
Engine type	OHC in-line 4	OHC in-line 4	OHC in-line 4	OHC in-line 4
Displacement (cu. in./L)	109/1.8	109/1.8	98/1.6	112/1.8
Compression ratio	8.5:1	9.6:1	9.5:1	9.1
Carburetion	F.I.	2-bbl.	F.I.	84 @ 5,200
Ner hp @ rpm	90 @ 5,500	107 @ 5,600	82 @ 5,200	84 @ 5,200
Net torque (ft.-lbs.) @ rpm	100 @ 3,000	127 @ 3,600	88 @ 2,800	102 @ 2,800
Transmission	5-speed manual	5-speed manual	5-speed manual	5-speed manual
Axle ratio	3.34:1	3.37:1	3.73:1	3.74:1
Tire make	Pirelli	Goodyear	Michelin	Goodyear
Tire type	P6 Cinturato	Eagle GT radial	TRX radial	Polysteel radial
Tire size	185/60R14	195/50R15	165/70R365	P195/70R13
Steering	Rack and pinion	Rack and pinion, power	Variable, rack and pinion, power	MacPherson strut with coil springs
Overall steering ratio	18:1	18.1	18.4-14.4:1	16-14:1
Turns, lock to lock	3.3	2.88	3.04	2.88
Turn diameter (ft.)	31.2	36.4	35.44	34.74
Front suspension	MacPherson strut with coil springs	Iso-Strut with coil springs	MacPherson strut with coil springs	MacPherson strut with coil springs
Rear suspension	Independent stabilizer axle, coil springs	Semi-independent trailing arm, coil springs	Independent modified MacPherson strut, coil springs	Trailing axle, coil springs
Front stabilizer-bar diameter (in.)	0.65	1.0	0.94	1.1
Rear stabilizer-bar diameter (in.)	0.81	None	n.a.	0.75
Trailer towing (max. lbs.)	n.a.	1,000	1,000	1,000
Trailer tongue weight (max. lbs.)	100	100	100	100
Brakes	Power, disc/drum	Power, disc/drum	Power, disc/drum	Power, disc/drum
Brake swept area (sq. in.)	n.a.	201.4	201.4	251.7
Fuel tank (gal.)	10.0	13.0	11.3	13.6
Trunk space (cu. ft.)	38.9*	27.3*	26.4*	12.6
Liftover height (in.)	31.0	31.4	31.2	32.8
Curb weight (lbs.)	1,825	2,363	2,063	2,380
F/R weight distribution (%)	64/36	62/38	62/38	65/35
Basic price	\$7,990	\$8,290	\$7,339	\$7,952
Price as tested	\$9,440	\$8,692	\$8,676	\$11,230
Major options (over \$100)	Sun roof \$285, A/C \$650	AM-FM-cassette \$402	Premium fogger \$124, rear sound \$117, AM-FM stereo \$109, power steering \$210, rear-window control \$109	Power seat \$210, electric locks \$120, power windows \$180, rear defogger \$125, A/C \$775, cruise control \$170, power steering \$199, exterior trim \$505

TEST RESULTS

Acceleration (sec.)	0-60 mph	1/4 mile	1/8 mile	1/4 mile
0-60 mph (sec.)	12.3	12.7	17.7	17.1
Brake test (cool) 60 mph	186	186	168	179
Stopping distance (ft.)	80	35	100	35
Pedal pressure (lbs.)	153	201	174	185
Brake test (hot) 60 mph	70	35	115	20
Stopping distance (ft.)	153	201	174	185
Pedal pressure (lbs.)	70	35	115	20
Interior noise @ 60 mph (dBA)	71	73	71	70
Handling test (mph)	63	66.8	70+	59.2
Maneuverability test (mph)	31.5	31	30.5	32.9

TEST CONDITIONS: Ambient temperature, 50°F; relative humidity, 75 percent; barometric pressure, 28.9 inches Hg *With rear seat folded

Performance comparison with selected 1983 models

	Mpg (city driving)	Acceleration 0-60 mph (sec.)	Brakes 60-0 mph (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
AMC Alliance 4	34	18.9	176	63.7	29.9	68
Ford Escort 4	33	15.6	173	61.2	30.1	66
Honda Civic FE 4	46	14.4	178	65	30.3	76
Plymouth Turismo 4	32	15.4	186	60	28	72
Pontiac 2000 4	31	15.1	148	63.6	27.7	69
VW Jetta turbo diesel 4	43	15.3	191	60	29.3	76
VW Rabbit diesel 4	43	23.8	157	62.8	29.5	73

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PS car test & driving report

market that Ford realized with the Mustang when that model's GT version was introduced last year. But the difference is critical: Escort GT is no hot performer. In fact, it was slower in the zero-to-60-mph run (17.7 seconds) than the standard Escort we tested in the January issue (15.6 seconds). We tested the GT repeatedly to verify the times, but the car would not kick out as promised. This was especially surprising since this model was equipped with multi-port fuel injection and a tube-header-style tuned exhaust manifold. One clue to the lack of performance: The GT version requires a shift to third gear to reach 60 mph, while the standard Escort rolls up to 60 in second gear.

In high-speed handling, though, Escort GT proved its mettle. Its 70+ mph time for the high-speed accident-evasion test was one of the fastest ever recorded by POPULAR SCIENCE and earns Ford a special salute. Low-speed maneuverability, as with the other cars in this test, was excellent, and Ford chalked up another perfect score in our rating table.

Inside an otherwise commendable passenger compartment, Ford continues to offer two unnecessary complications: The two-hand key release for the ignition is a bother, and the horn button on the turn-signal stalk can only be reached with the left hand.

As in the standard two-door Escort, there is ample room for four passengers. The rear seat, generously padded for a fold-down type, is on a par with the Rabbit's for comfort. However, the entrance to the rear seat is obstructed by the seat-belt anchor.

An excellent option is the \$109 rear-window control system, which allows the driver to open or close the push-out windows from the front seat by moving a lever on the center console.

Buick Skyhawk T Type

For '83, Buick has a whole line of T Type models that are designed to heighten driving enjoyment. (See last month's car test for our report on the Century T Type four-door sedan.) In Skyhawk, the T Type package concentrates on handling and interior customizing but not engine performance. Its suspension system is called "gran touring" and includes larger stabilizer bars, a special front strut, and a low-ratio steering gear. Forged-aluminum wheels and 70-aspect-ratio radials round out the handling adjustments. Inside are custom bucket seats and extra instrumentation.

High-speed handling, however, was a disappointment, but that could be traced to the relatively tame Good-year Polysteel tires, which didn't have the bite and hold that the tires on the other test cars showed.

It is interesting to note that, with all the other changes, Buick has not made any performance modifications to the 1.8-liter four-cylinder engine in this sporty car. This new-for-1983 engine, imported by Buick from GM of Brazil, does provide quicker acceleration than last year's 1.8-liter, but it isn't in the same league as the high-performance ones in Rabbit GTI and Shelby Charger.

A flaw in the engine's mounting arrangement produces a jiggle when power goes from off to on at just about any speed. The car body shakes as the engine shifts on its mounts, hits a limiter, and rebounds. On all other counts, though, the high-revving overhead-cam four is a big improvement over the 1.8-liter Chevrolet engine used in J-cars last year. In fact, it may even be a better performer than the two-liter (122 cu. in.) Chevy four that is standard in Skyhawk this year.

Skyhawk wins the award for excellence of interior trim and appearance. Its black-and-gray exterior paint theme is carried throughout the driver's area and creates an aura of nonsense efficiency. The highly contoured power-positioned seats match the best bucket-type seats in the industry. The instrument panel is easy to read and has essential dial gauges, including a tachometer, which shares a prominent position along with the speedometer.

GM still has a way to go before its J-cars are completely refined, but Buick Skyhawk shows definite progress. If it continues, and if the T Type theme spreads to standard cars, the Skyhawk should become the strong import fighter that Buick originally planned.

Our choices

The GTI is an improvement on a solid car. It feels, sounds, and is exciting to drive. The whole package finally brings European-style driving performance to the U.S. economy-car class. VW is miles ahead of the competition.
—J. D.

The Escort GT's handling and price could have made it my pick. However, a performance car should have a performance engine. Price, performance, and understated good looks made the Rabbit GTI my favorite. —J. K.

Two folding bikes — easy to pack, easy to pedal

Fold-up bicycles are certainly not a new idea. The first American patent for one was issued almost 100 years ago. Now, however, as the surge in fuel costs and the increasing emphasis on physical fitness lead more and more commuters and pleasure travelers to turn to pedal power for transportation, many are "discovering" the portable bike. Two new designs are meant to appeal to different portions of the booming fold-up market.

The Shomo folding bicycle (below) was designed to duplicate the look, strength, rigidity, and ride quality of a conventional 10-speed touring bike, according to inventor Robert Shomo. Yet it folds into a portable 36-by-36-by-12-inch package. In addition to the central frame joint, the handlebars fold in half and the pedals can be tucked in. Folding or unfolding requires no tools or assembly and takes less than 30 seconds, Shomo says. In the riding configuration, the frame locks positively and rigidly. Price: \$199 from SFB Manufacturing Co., Box 2128,



Dearborn, Mich. 48123. Some of the bicycle's components, including the unique handlebars and pedals, can be purchased separately.

The Hon folding bicycle (above), not yet on the market, is aimed primarily at bike commuters. But it offers the performance, ride quality, and safety of conventional bikes, says inventor Dr. David Hon (2522 Banyan Dr., Los Angeles, Calif. 90049), so pleasure riders might like it, too. When folded, it's smaller than any bike on the market—27 by 18½ by 8½ inches, small enough, Dr. Hon suggests, to fit under the seats of commuter trains and buses. He pictures suburban riders pedaling to local commuter stations, thus escaping reliance on the family car. Unfolding is accomplished in five easy motions taking less than 15 seconds, the inventor says. Its 16-inch wheels are compensated for by a large sprocket ratio, which yields the ride of a full-size bike. The bicycle, which is being manufactured in Taiwan, will sell for about \$250. Dr. Hon expects it to be available through bicycle shops later this year. It can be equipped with one to 10 gears, and the seat post is adjustable for riders from 4½ to 6½ feet tall.—Dan Ruby



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THROUGH THE VIEWFINDER

By EVERETT H. ORTNER



A first from Fuji

Drop-in loading is the kind of thing you associate with Instamatic cameras—110s and 126s—not 35-mm cameras. Now Fuji has found a way to incorporate true automatic loading (not just automatic film advance) in two new 35-mm lens-shutter cameras, the Fujica DL-100 and DL-20, scheduled for introduction this spring. The secret is a back cover hinged at the top. You release the cover catch, open the cover (it doesn't come off), and drop in the film. A hollowed-out opening accepts the cartridge; the film leader slips into a slot. Close the back, and the camera automatically winds the film to the first frame.

If you use Fuji film, the DL-100 also automatically makes its own film-speed setting, either 100 or 400. (You set the camera manually for other film speeds or non-Fuji films.) Other DL-100 automatic features: autofocus via an infrared sensor, auto winding after each shot, auto rewind when the roll is finished, auto exposure control, and flash automation.

The simpler DL-20 offers drop-in loading plus motorized film winding and rewinding, built-in flash, and automatic exposure. Prices? Not yet set.

Kodak's new film family

In my February column, under the heading "Kodak Bats 1000," I reported the in-

roduction of a Kodachrome film with an ASA of 1000. Now that film has been joined by three other new Kodachrome films with speeds of 100, 200, and 400. They form a family, designated by "VR," that will replace present Kodachrome films.

The creation of Kodachrome VR 1000 is based on a research breakthrough that Kodak executives call the "most significant development in emulsion technology in 50 years"—or since the development of Kodachrome. Up to now, increasing the speed of a film has also meant increasing its graininess or decreasing its sharpness, or both. The reason: It has usually required increasing the size of the silver halide grains—the light-sensitive element in the film's emulsion. And of course the bigger these get, the more visible they become—and the grainier the picture. Along with that, sharpness is reduced, as big grains do not show details with the fidelity of small grains.

The new emulsion technology changes that by changing the shape of the silver halide grains. Generally, they are octahedral; they resemble pebbles with eight planes. The grains in the 1000-speed film are flat and tabular shaped, offering more surface and thus greater light-capturing ability and speed. Kodak calls them "T-grains," for their tabular shape.

The significance of T-grain technology extends beyond Kodachrome VR 1000. All standard films, color as well as black-and-

white, depend on silver halide grains for their light sensitivity. There is little doubt that the new technology will be extended eventually to all Kodak films, with gains in speed, finer grain, and sharpness.

All four Kodachrome VR films embody new chemistries that can be traced to the enormous research effort mounted by Kodak during the development of disc photography. "Image sharpness can be improved chemically as well as optically," says Judith Schwan, assistant director of Kodak research labs. The developments here include a new development inhibitor releaser (DIR) in the dye layers and new dye couplers. DIR molecules can be designed to particularly affect the development of grains that form the edges of details in an image. They can be made to compensate for light-scattering and diffusion effects that might otherwise make the edges look fuzzy.

Here's a rundown on the new films:

- Kodachrome VR 100. Very high sharpness and extremely fine grain, permitting great enlargement.

- Kodachrome VR 200. High sharpness and extremely fine grain equal to Kodachrome II, permitting good enlargement.

- Kodachrome VR 400. Medium sharpness and extremely fine grain, permitting moderate enlargement.

- Kodachrome VR 1000. Medium sharpness and very fine grain, permitting enlargement to eight by 10 and sometimes larger.

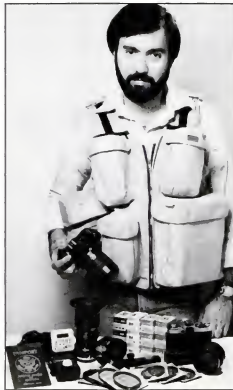
All four films are designed for daylight or "equivalent"—Kodak's term for flash or controlled lighting—but don't worry too much about the kind of light. All come in 12-, 24-, and 36-exposure rolls, except the 1000, which comes in 12 and 24 only. And all use standard Kodak C-41 processing just like their predecessors.

When can you get them? Late April for the 1000 film, the others in July.

For professional photographers, Kodak is introducing Vericolor III professional film, type S. It is faster than its predecessor (160 vs. 125), has improved color (particularly with skin tones), and can be stored for longer periods without significant change. "Type S" indicates that it is designed for short exposure times (1/10 to 1/10,000 second) and is balanced for use primarily with electronic flash—a major tool of portrait and wedding photographers—and daylight.

Ever-ready vest

Not a fishing or hunting vest modified for photographers, but a true photographic vest, designed for photographers by photographers, claims Spiratone (135-06 Northern Blvd., Flushing, N.Y. 11354). The main pocket (8½ by 10 by 3½ in.) holds up to three SLR bodies or lenses up to eight inches long. Two four-by-2½-by-6½-in. breast pockets hold lenses, filters, flash, etc. Another (the same size) below holds more of the same. And two zippered flat pockets (4½ by 5½) plus elastic straps at the shoulder for film cans round out the vest. It's made of heavy cotton duck lined with nylon mesh. Price: \$15. But there's a hitch: You have to buy \$50 worth of other stuff with it. Catalog: 75 cents. E3



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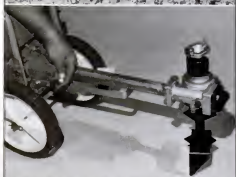
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Long-arm tiller for tight spots



Balance is the key to tiller's easy handling (top). By loosening lever nut you can turn head to vertical or inverted position. Bottom: Vertical shaft drives weeder.

My first reaction to the Masport tiller was that it was intended for petunia beds tended by little old ladies, not for hard-packed, weed-filled vegetable gardens.

I was wrong. Starting with an area of my garden that had been fallow for two years, I was amazed at how the machine chewed the soil.

The worm-driven, out-front tines, powered by a three-hp engine, are easy to see and guide precisely. The tiller power head inverts for counter-rotation fine tilling and twists to vertical, making it a small weeder or shallow cultivator. The machine also accepts an edging disc for walks and driveways or a rotary brush for scrubbing. It fits into the trunk of a car.

Made by Masport America, Inc. (200 Gate 5 Road, Sausalito, Calif. 94965), it's \$450.—E. F. Lindsley.

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V8-6-4 economical no more

At first my 1981 Cadillac de Ville gave me 29 mpg, but that fell off; now I'm lucky to get 14 on the highway and seven in the city. My dealer and customer-relations man can't—or won't—help. I'd guess the problem is with the on-board computer. How can it be corrected?

Stanley Cerisano
North Bay, Ont.

Your engine model has received much criticism. As you suspect, the electronic control and associated systems are involved. It's complex and fixable only by trained technicians with all the latest bulletins and equipment to work with. When these systems go awry, there's no place for trial and error or guesswork: Everything suddenly starts changing, including some things that are dangerous and downright unpredictable.

Throbbing cat

When driving my 1979 Mercury Cougar above 55 mph, I hear a throbbing noise. I can also hear the noise when the car isn't moving.

Lester M. Howard, Greenville, Tex.

Look for an out-of-balance alternator. Unhook the belt for a few minutes to see if the throbbing stops. If it does, balance or replace the unit.

Fiesta won't fire

After spending \$600 for an ignition-amplifier module, tuneup, carburetor rebuild, fuel filter, ignition-switch module—plus trouble-shooting time—my 1978 Ford Fiesta still won't start after being driven for 15 minutes and allowed to stand for 20 to 45 minutes. If I let it cool for an hour or more, it starts fine.

Tom Yates, Greeley, Colo.

The trouble you're having is a long story, and it's covered in *Ford Bulletin* 161, Article 3268. It involves fuel getting too hot and flooding. You'll have to install a fuel-enrichment-valve restrictor.

It's all in the spark

The pinging in my 1980 Oldsmobile Cutlass 260-cu.-in. V8 is unbearable with 87- or 88-octane gasoline. Retarding the timing and burning 91 or 92 octane helps, but it still pings. The car has only 5,500 miles.

R. Granell, Unionville, Conn.

Try switching fuels; they're not all the same. But the real fix is to get the spark advance out quick but also back in quick. When manifold vacuum drops and the

load goes up, the spark advance has to come flying out. Your car has over 55 deg. total advance at high rpm and high vacuum. Maybe an Autotronic (6906 Commerce St., El Paso, Tex. 79915) manual in-dash spark control or Crane Cams' (Box 160, Hallandale, Fla. 33009) adjustable vacuum advance will help you a little. I can't figure out why they are building cars we don't have fuel for.

Extreme X-car case

My 1980 four-cylinder Buick Skylark with only 33,000 miles has the following history: Fan failure at 5,000 miles damaged the radiator; head gasket blew at 18,000 miles and again at 25,000; transmission was overhauled and a new torque converter installed at 27,000 miles; main-bearing failure required a new short block at 27,500 miles. My car was and is well maintained. Is it just that X-cars are bad news?

R. J. Matlock, Katy, Tex.

What I hear suggests that the X-car isn't doing too well, but your case is extreme. I believe that you need more car for your driving style and terrain. Also, the repeat of the head-gasket episode suggests that your service agency doesn't thoroughly understand the engine.

Sluggish Bonneville

My Pontiac Bonneville is a 1979 model with a Buick 350-cu.-in. engine. It's been in the shop repeatedly because it's sluggish and hesitates when cold.

Leland Anderson, Glenwood, Ill.

I doubt that the choke is on long enough. So many of these complaints are given a little of this and a little of that by the dealer. That doesn't get it. The choke setting has to be made exactly by the numbers or it won't work. Find a place that will do it by the manual. Also, exhaust heat and EGR have temperature sensors: The EGR system should not be operating during a cold start. Timing is ported and must be hooked up right; so must the fuel-vapor canister, PCV valve, and manifold-vacuum line. All these things are critical to cold start.

Costly transmission fixes

At just over 40,000 miles the five-speed transmission in my 1977 Datsun King Cab pickup truck wouldn't shift into second and jumped out of fifth. Datsun said it was synchronizer trouble and fixed it for \$350. At about 75,000 miles it happened again, except second wasn't involved and Datsun again said it was synchronizers. This

time the repair cost was over \$500. Now at 80,000 miles, second gear has become inoperable. Is this a design flaw in Nissan's five-speed, and am I wrong in feeling the costs are excessive?

Richard Martindale, El Dorado, Kan.

I consider the transmission to be too light for rough service, heavy loads, and high speed. Look for better lubricant, and investigate the operating temperature of the transmission. Is the transmission lined up within 0.003 or 0.004 in. of the engine? Have it checked. The price of those parts makes me wonder if all the bandits are gone.

Oily air cleaner

My 1977 Pontiac Ventura has 63,000 miles on it, and now oil is coming into the air cleaner via the hose from the valve cover. The car runs fine and averages 24 mpg. What's wrong?

Nick Plooy, Lamont, Alberta

The crankcase venting is goofed up. Your dealer has a service bulletin—better get him to look it up.

Manifold gaskets blow

The intake-manifold gaskets continue to fail on my 1979 Ford LTD with 351-cu.-in. engine. I have replaced them three times in three years. The Ford people say they know no solution.

Leonard E. Schultz, Nashville, Tenn.

Check the fit of the manifold and have it surfaced, if necessary. Clean the head surfaces and glue the gaskets to the heads with 3M yellow weatherstrip cement. Paint the manifold side with aluminum paint and pull it down good while cold and again while hot.

Converter plug-up?

The manual for my Dodge Coronet warns against additives that could damage the converter. I've been using STP gas additive for three years. What happens when a catalytic converter goes bad? Also, why do disc-brake pads ride on the disc instead of retracting like drum brakes? Don't they overheat or wear?

William Anderson, Marquette, Mich.

When converters are subjected to chemistry other than no-lead fuel they either die chemically or plug up and increase exhaust back pressure. This can cause very poor running. Disc brakes, as a rule, depend on some disc runout to set them back a few thousandths of an inch so they don't drag. Still, they do accumulate some wear.

Each month, Smokey Yunick answers questions on cars—family cars, high-performance models, and racing vehicles. Got a problem? Send it to: "Say, Smokey—", POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. All letters are read, and those of widest interest are answered in this column. Due to the large volume of mail, Smokey cannot reply to letters that are not selected for publication.

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To assemble this collection, the staff of the Country Music Foundation carefully reviewed the Foundation's own archives of 75,000 records. In addition, they enlisted the support of all the country music record companies — whose vaults hold many of the master recordings selected for this collection. And they were able to obtain rare recordings from private collectors and country music artists themselves.

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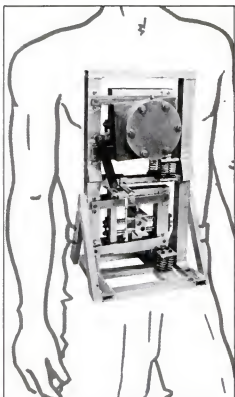
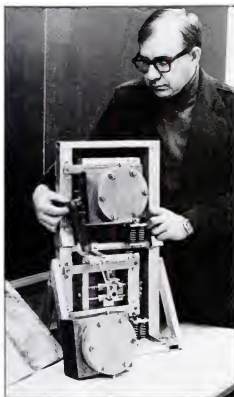


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Ride monitor

measures vehicle
bounce and shake



Now a machine makes
objective judgments
about ride comfort

By TIM PELTON

Dr. James C. Wambold drives along a badly potholed road in a new Dodge Charger. He and his passenger are testing and recording the vehicle's ride comfort. Wambold, a professor of mechanical engineering at Penn State University, makes a sharp turn, accelerates, brakes hard, and intentionally hits a bump or two. There is no friendly chatter between these road testers. This is serious business; besides, Wambold's fellow ride-comfort expert isn't human. It doesn't even look human.

Wambold's ride-comfort device consists of a spring-and-mass system used to simulate the height, girth,

weight distribution, and even the tissue elasticity of a 170-lb. man—but certainly not his appearance.

At first glance, it resembles more closely a piece of abstract sculpture than a precisely tuned instrument for measuring how much passengers are shaken up by a given combination of vehicle, speed, and road conditions.

A vertical aluminum frame supports two spring-mass-and-damper subsystems. These subsystems mimic the way energy is dissipated by the chest and abdomen of a human seated in a moving vehicle. Accelerometer and amplifier systems measure the lateral and vertical forces acting on the spring masses, and this information is recorded on a graph.

Wambold hopes that by creating an objective method for testing ride comfort he can eliminate many of the problems associated with earlier testing procedures. Ride-comfort tests that were run before Wambold's de-

vice was created usually required many people to ride in a test vehicle and comment on what they felt. These large numbers of people were required to rid trials of errors caused by random variations. Precise answers were often tough to get, and the moods of the test persons affected their perceptions and thus the test results.

Wambold's device can be used in a standard vehicle to test the surfaces on many roads, or it can be used on a standard road to test the ride comfort of various vehicles. Another important benefit is that the device can be used in new vehicles that have not yet been determined safe for people. At one time, test subjects were sometimes injured in prototype vehicles.

Today, high standards exist to protect test persons. In fact, Wambold had a great deal of trouble getting permission to do simple side-to-side vibration tests with humans to gather data for the development of his ride-comfort device.

Some previously unknown data emerged during those tests. When Wambold's work began over a decade ago, he believed that the monitor would be humanoid in form, resembling a crash dummy. But it was found that crash dummies simulate body reactions to small vibrations no better than sandbags. The spring-and-mass subsystems seem to most closely approximate the reaction of living, connected tissue to bumps and jolts. A parallel linkage and a set of springs hold the subsystem masses loosely in place so they can move freely when acted upon by ride forces.

"Thus far," says Wambold, "we've learned that rough rides are better endured during warm weather, presumably because bodies are more limber. We also found that women's bodies don't resonate as readily as do men's at two critical and annoying side-to-side vibration frequencies, possibly due to their less rigid hip structure. We've also confirmed other researchers' findings that a passenger's mood affects perceived ride comfort."

Wambold's research team also discovered that human bodies resonate near two frequencies, 4.5 and eight Hz, so the device was tuned to resonate at those frequencies.

The last bit of information is bad news for those of us living in the Northeast. This part of the country happens to be the worst place for ride comfort, especially during early spring. At that time, thawing roads cause sharper vibrations while riders and vehicles are still stiff from cold weather.

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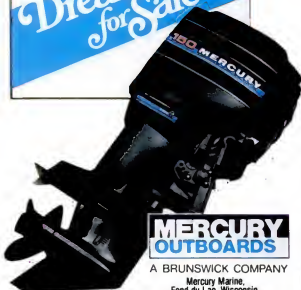
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Heavy-duty tractor saves time and work

I spent an entire summer testing the Wheel Horse C-195 with its 19-hp, cast-iron Kohler engine and hydrostatic drive. It underscored my feeling that there's no substitute for a tractor designed and built for big jobs.

The 60-inch mower deck and fast ground coverage reduced cutting time in my yard from 27 to 19 minutes. And the tractor pulled the 50-inch rear tiller with a three-point hitch through a tough, untilled garden plot effortlessly.

The C-195 has two hydraulic controls: one for the deck and the other for the rear implement. This means there's no linkage switchover and readjustment necessary. When the tiller is slipped off the spline drive, the drive belt, rear power takeoff, and hitch can be left in place when you mount the mower. Once the mower lift is hooked to the deck, the hydra-



A spline-drive power takeoff drives the Wheel Horse 50-in. tiller even when the

going is tough. Pinion and sector gear keep the steering light and responsive.

lic lift pulls it up into latched position. The changeover is fast and relatively easy.

As could be expected on a tractor in this class, the C-195 has an hour meter, ammeter, 15-amp alternator, hydro-drive-disconnecting clutch, head-

lights, and a 4½-gallon fuel tank with gauge. The basic tractor costs \$4,899. The three-point hitch is \$330; rear power takeoff, \$225; 60-inch mower deck, \$899; tiller, \$999. Wheel Horse, Box 2649, South Bend, Ind. 46680.—E. F. Lindsley



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16 mg "tar," 1.0 mg nicotine av. per cigarette, FTC Report Dec '81

PS | What's News

Smokey Yunick is constantly full of surprises. Not only does he enjoy a reputation as one of the best race-car designers and mechanics of all time, but he is also the owner of a highly successful diesel-truck service garage and an engine designer and trouble-shooter who frequently takes on advanced projects for Detroit auto makers.

We've reported on a number of Yunick developments before, but none, I think, more exciting than this one. Smokey's goal: to save some of the heat energy thrown away by the average automobile engine in the exhaust, through the radiator, and elsewhere. In the average engine, some 75 percent of the heat generated by burning fuel is wasted, while only about 25 percent is actually put to work making the engine turn. Obviously, if you could save only *some* of the wasted energy, engine efficiency would go up sharply.

This isn't confidential information; every basic engineering text spells it out in great detail. And a lot of engineers have tried to figure out how to stop the waste. But so far there have always been problems. Smokey apparently has figured out a way around them. To learn of his solution, turn to Al Linsley's article. The cover painting was done by Ray Ploch, who also did the working drawings that accompany the article.

The deflated bulge

The famous Palmdale bulge [PS, Nov. '76] that has had Southern Californians in such a shaky state for several years may not be dangerous after all. Because it may not exist. That's the message in a paper published recently in the *Journal of Geophysical Research*.

The piece, by Sandford R. Holdahl of the National Oceanic and Atmospheric Administration, says there may be a simple explanation for the Palmdale bulge: measurement error. Holdahl points out that information on the elevation of the earth at any given location comes from survey data. Surveyors make the measurements using something called leveling procedures. Traditionally, this involved looking through a carefully leveled telescope and reading numbers off a calibrated pole in the distance. These days it's done by focusing a laser beam at a target in the distance. In either case, it can be done over quite long distances. Sur-

veyors often do their leveling procedures along railroad tracks, both because the long, gentle slopes allow them to take readings easily and because they can use railway handcars to get from one location to another.

There are errors in the procedure that have long been recognized. Temperature differences in the air along the line of sight refract or bend the travel of light rays, thus introducing error. And since the roadbed soaks up a lot of solar energy and uses it to heat the air in the immediate vicinity of the track, refraction error is more severe along tracks than across the open countryside. Such errors, however, were thought until recently to be small—even negligible.

The ominous rise of about one foot in the level of the earth in the Palmdale area was first measured in 1965. But Holdahl points out in his paper that in 1964 a new instrument was introduced in leveling operations. It was useful only over shorter distances. That would have reduced refraction error. Holdahl recalculated the elevation of the Palmdale area, accounting for a change in refractive error. The result: The bulge disappears.

Of course, nothing has been heard from the engineers who made the survey or from the geologists who have interpreted the rise as a sign of probable approaching earthquake activity. But whatever the outcome, it does show clearly that even the most careful work can have hidden flaws. And it emphasizes the importance of maintaining at least some skepticism over any new development.

Blowing in the wind

● The Bureau of Reclamation has just accepted delivery of the world's most powerful wind turbine. The 4.8-megawatt unit is located near Medicine Bow, Wyo. When it is operating, it should supply the electrical needs of 1,500 homes.

Proponents say that enough windmills to produce 5,000 megawatts could meet the electrical needs of two million homes. They'd generate energy equivalent to that which could be produced by burning oil at a rate of approximately 25 million barrels a year.

The big new windmill was made by the Hamilton Standard division of United Technologies. Hamilton Standard, of course, has been manufacturing airplane

propellers for decades. The new wind-turbine blades are 125 feet long and weigh 15 tons each. They're mounted on a 250-foot tower, and the nacelle on top contains generating equipment and necessary computer controls.

● A storm recently ripped through California's Altamont Pass, where several hundred windmills have been installed [PS, Jan.] to capture the energy in the powerful winds that whistle through the area. The storm, with winds above hurricane force, knocked down five huge high-voltage transmission towers, plunging the whole region and more than two million people into darkness.

But the hundreds of wind towers made it through the blow without damage. All had provisions for shutdown and feathering the blades during exceedingly high winds. Stephan Jasan, operations manager for U.S. Windpower, said the blow just proved that Altamont Pass is a very windy place—and an ideal location for a giant wind-power project.

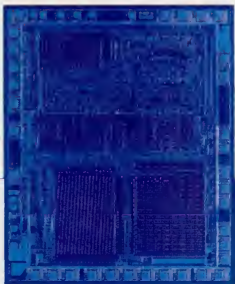
● Contrasting to this bright news from the wind-power front is almost nothing but gloom, generated by two concurrent facts: The Reagan administration has cut back about 90 percent on the research budget for alternate energy. And private industry, with oil prices sagging, is unwilling to continue alone. The payback period apparently seems too long and the eventual payback too uncertain. Thus 1982 witnessed such dismal events as the abandoning of most attempts to develop shale-oil reserves, shutting down of much solar-cell research and many other projects involving alternate energy, and a cutback in the number of companies competing in the solar-energy field.

There is, however, at least slight encouragement in the recent words of Energy Secretary Donald Hodel: "We are not going to be able to invest in every good idea, but the United States can't afford to slam the door on any technology and then find that the rest of the world has passed us by."



Editor-in-Chief

MACHINES WITH COMMON SENSE



Shrinking the dimensions of circuit components lets engineers put entire systems on one silicon chip. Square chip (top) is Bell Labs' 32-bit microprocessor with 150,000 transistors. Rectangular chip below it, a 256-kilobyte memory, has 600,000 transistors. An American Microsystems Inc. engineer (left) uses a computer terminal, which displays mask pattern for IC. Computer programs can customize chips, such as AMI's 16-bit microcomputer (above), for special applications.

I. Superchips

Tiny microcircuits bearing millions of transistors are being created by—and for—more-powerful computers

By JOHN FREE

ILLUSTRATIONS BY GENE THOMPSON

A silicon wafer, bearing dozens of fingernail-size microcircuits, or chips, floated smoothly past me on a cushion of ultra-clean air.

Bathed in filtered yellow light, the disc vanished down a 100-foot enclosed plastic track. Location: International Business Machine Corp.'s automated microcircuit production line—one of the most advanced in the world—in the firm's East Fishkill, N.Y., plant.

A computer awakened baby-size robotic arms in a cabinet nearby. The arms plucked silicon discs from trays, dunking them into chemical baths. "Families" of computers guided wafers from one automated tool to another.

"Over there in the corner are some of the computers—IBM 370s—that help control everything," said engineer Bill Mayo. Technicians bustled about several of these refrigerator-size models. A single superchip from a wafer, I knew, could carry the computing power of a vintage IBM 370 main-frame computer—itsself based on integrated-circuit (IC) chips.

The scene before me illustrated a fascinating paradox. With the demand for faster, more-sophisticated computers, there's a need to jam ever more parts onto chips. To make these super-dense microcircuits, engineers are forced to develop ever-more-sophisticated design and manufacturing techniques. This new technology has become so complex that computers have become essential to design computer chips. And so precise is the control needed to manufacture superchips that computers are becoming essential on assembly lines, too.

This process of shrinking electronic circuits into ever-smaller areas—called very-large-scale integration, or VLSI—is at the heart of the current revolution in computers and telecommunications. As engineers and scientists in Japan create fifth-generation computers (see adjacent article), chips will be needed with far greater complexity and operating speed than those available today.

Advanced computers that analyze problems with human rules of logic and expert systems [PS, Sept. '82] enhanced

(Continued on page 150)

II. Fifth-generation computers

Hardware that can see, listen, talk, learn, and make judgments is the goal for the early 1990s

By JIM SCHEFTER

TOKYO

Hozumi Tanaka turned to his computer terminal and typed an English sentence: "I have some eggs in my hands."

Seconds later, the sentence scrolled across the screen in katakana, the Japanese characters that are so bewildering to Westerners. The demonstration was the result of three years of effort for Tanaka at the advanced Electro-Technical Laboratory (ETL), about 70 miles from Tokyo.

His language-translator program easily shifted between Japanese and English, forming perfect sentences in either language at the touch of a button. Still, given the bewildering array of grammatical rules that had to be defined for the computer by Tanaka and his small team of software specialists, the machine's English vocabulary had reached only 100 words.

"We've proved the concept," Tanaka told me. "Now we can start on the big program, a language translator for routine use." That program, still three to five years away, will be delivered to another lab in Tokyo to simplify communication between an extraordinary new type of computer—the so-called fifth-generation computer—and its eventual users.

At the lab, a team of elite designers is already studying computer circuits unlike any ever seen. Other teams are tackling new forms of complex software intended to revolutionize computer technology.

After its overwhelming success in the automobile and consumer-electronics markets, Japan is beginning to build a computer so advanced that its development ranks as a national project. This fifth-generation computer is to be perfected and turned over to private industry by 1992.

If it works, the machine will incorporate artificial intelligence (AI) concepts and rival the fictional HAL of "2001." Japan's fifth-generation computer will:

- Listen when you talk, then do what it's told.
- Help program itself.

• Sort through volumes of facts to find and use only what's pertinent.

Continued

II. FIFTH-GENERATION COMPUTERS

- Make logical inferences.
- Translate foreign languages.
- Treat images and graphics the same as words ("see" and "understand" a photo, for example).
- Learn from its own experience.
- Come in both portable and fixed-base systems.

The fifth-generation computer will use advanced forms of very-large-scale-integration (VLSI) chips—semiconductor chips that have higher component densities and are capable of much higher speeds than those available today [see "Superchips," this issue]. The Japanese machine will have new forms of computer architecture: Instead of one central processor—the "brain" of a computer—or even several processors working simultaneously in parallel, Japan's machine might have a million or more small processors operating in parallel.

The fifth-generation machine may be able to perform up to 70 times more calculations each second, and have 3,000 times the internal memory of supercomputers now in use, such as the Cray-1 [PS, June '79]. (The fifth-generation designation follows four earlier technologies: vacuum tubes, transistors, integrated circuits, and large-scale-integration chips.)

What will such computers do? "This project is the space shuttle in the world of knowledge," University of Tokyo professor Tohru Moto-oka has said. Two target applications are language translation and consultation systems. The goal with translations is for multiple languages, a 100,000-word vocabulary, and 90 percent translation accu-

racy. The remaining 10 percent would be handled by humans.

Consultation systems include medical diagnosis, natural-language and speech interfaces, intelligent-computer-aided design, the ability to be tailored for use as an expert consultant in diverse subjects, and computer troubleshooting and diagnosis.

The goal is to include a capability for semi-automated knowledge acquisition. The computer may, for instance, monitor news reports, read books and newspapers, draw information from other computer data bases, or simply listen to an academic lecture. It would decide what to remember and what to ignore with a minimal amount of human intervention.

The formal program to build the world's most advanced computer began in late 1981 when, after three years of planning, Japan's Ministry of International Trade and Industry announced the \$300 million fifth-generation-computer project. Funds were committed in advance for the first three years of work. The ministry, which operates ETL and other laboratories, pooled resources with eight of Japan's largest electronics firms to open the Institute for New Generation Computer Technology (ICOT) in April 1982. ICOT's mandate is to develop a new computer family with the software and hardware for AI.

Though the U.S. still leads in AI research, efforts concentrate on software for the current crop of computers. ICOT takes a different view: "... [Computers] must evolve from machines centered around numerical computation to machines that can assess the meaning of information and understand the problems to be solved," states ICOT's research-and-development plan. The first step is to design and build "mechanisms for inference, association, and learning in hardware."

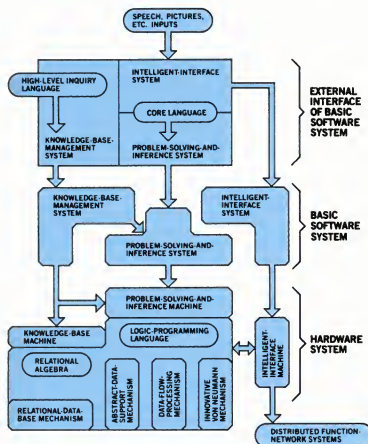
That's a tall order. "User-friendly" software is just becoming commonplace for today's computers, and expert-system software [PS, Sept. '82] remains largely experimental. The Japanese intend to create "man-machine interfaces that are natural to man." That means talking to the computer or typing instructions in everyday language; showing it charts, graphics, and even photos; and getting back information the same way.

Beyond von Neumann architecture

In their work, computer engineers speak of a machine's "architecture." The term refers to the general design of the circuitry, the overall logical scheme by which it will take in information, manipulate it, and produce a result. To date, essentially all computers have used so-called "von Neumann architecture," which grew out of the work of the famous mathematician. In a standard von Neumann machine, a single central-processing unit (CPU) handles calculations. Each step is performed individually, one after the other. Each calculation is called a floating-point operation and a computer's speed is measured by how many million operations it can perform each second. In computerese, this measurement becomes a "megaflop." Large main-frame computers today are typically rated at around two megaflops.

But regardless of whether the computer is performing an arithmetic calculation or translating a word from Japanese to English by comparing data with information in its memory, a von Neumann machine performs one task at a time according to the sequence in its program.

This step-at-a-time sequence is too slow when huge amounts of data must be arithmetically processed—in "number-crunching" computations such as weather forecasting, for example. For this, computer scientists came up with a technique called parallel processing, and engineers devised the computer architecture to handle it. A few ad-



Hardware configuration of fifth-generation computer will be based on a large number of VLSI chips, each with a central processor, memory, and communication circuits to speed computing by parallel processing—solving problems and drawing inferences by operating on small portions of the problem simultaneously. The computer will be linked into larger networks.

vanced supercomputers, such as the Cray-1 and Control Data Cyber 205, have multiple processor chips to divide up the work under control of a central processor. These processors can speed computations greatly by solving portions of a problem simultaneously—in parallel. The processors could translate many words at one time between languages if given the task, but those supercomputers are used for scientific number crunching, not as general-purpose machines.

The Cray can theoretically run at 140 megaflops, and the Cyber 205, it's claimed, can perform 800 megaflops for rare categories of pure mathematical calculations. But in practice, programming complexities often limit both machines to 20 megaflops.

A special form of parallel processing, called dataflow, was first proposed at the Massachusetts Institute of Technology to increase computing speed still further. The dataflow idea requires a computer with a large number of processors, each with small amounts of individual memory and all embedded in a complex communications network that allows free exchange of data between any two processors without going through a central processor. The processors operate on data depending on "tags" attached to it; after performing a calculation, the processor tags its data and passes this portion of the overall solution—it might be a language translation—on to the next processor. These multiple operations happen simultaneously until the last two results funnel into a single processor, which performs the final calculation. A variety of experimental dataflow-architecture machines are being built.

Obviously, fifth-generation project engineers are looking at advanced architectural schemes for their projected machines. But despite reports in the Western world, Dr. Kasuhiro Fuchi, director of the ICOT Research Center in Tokyo, said the first machine will not be based on dataflow architecture. It will pursue new and yet-to-be-defined architecture designed solely for an inferential computer.

"We think we can take advantage of dataflow," Dr. Fuchi said, "but we will pursue parallel-type processing well advanced beyond that concept."

The Japanese expect their fifth-generation computer to be rated between 1,000 and 10,000 megaflops for general use. To get there, they will design a machine with many small processors—a million or more packed into VLSI chips is not out of the question—to handle simultaneous operations.

Very high speed will be essential for an AI computer that must race through its memory banks to make inferences. In simplest form, that means reaching a conclusion based on available facts, then using that conclusion as if it were a fact already stored in memory. To make one inference, a computer requires between 100 and 1,000 steps. The best machines today can handle only 10,000 logical inferences per second (LIPS). "Our target is between 100,000 and one million LIPS," Dr. Fuchi told me. "That will be a true knowledge-base machine."

Building a knowledge base

The differences between the data-base computers of 1983 and the 1992 knowledge-base computer are profound. A data base, Dr. Fuchi said, is simply a collection of facts. A knowledge base includes facts, instructions on how to use the facts, and information on how the facts relate.

More important, computers now need software to use a data base. The Japanese plan to build their knowledge-base core into the hardware. It will be an integral part of circuit design.

"Our initial hardware work will be analyzing everything known about VLSI technology and building a prototype machine," Dr. Fuchi said. "But the prototype at the

end of the initial development stage will be very primitive compared with the prototype at the end of 10 years."

The first fifth-generation prototype, to be ready by 1985, will be a personal computer. This small computer will not use parallel processing but will be the test bed for new high-speed VLSI circuits. It will have an amazing 80 megabytes of internal memory.

In the final three years of the project, ICOT will produce and test an all-new prototype computer to be called the parallel inferential machine. It will blend the earlier work into one machine intended to meet all goals. Its active internal memory will not be sized for several more years, Dr. Fuchi said, but will be at least 100 billion bytes—or the same as 3,125 Cray-1 supercomputers.

Dr. Fuchi expects no problem in developing the basic VLSI chip for the fifth-generation computer. But tying as many as one million chips, each containing a processor, some memory, communications links, and perhaps other circuits, into a workable system is a formidable task. And it's compounded by the need to design and integrate the communications network, main memory, and other elements into the computer.

“Our national strategy in computers has always been to match IBM. Now we have changed. Instead of equaling IBM, we want to develop new technologies”

In addition, ICOT is seeking international cooperation, both from other governments and from private industry, particularly IBM, which is both feared and respected in Japan. "Japan has succeeded in catching up with U.S. technology," Yoneji Masuda told me. "And with IBM." Masuda is a computer expert, technical consultant and adviser to high Japanese officials, and president of The Institute for the Information Society, an international group working on dataflow and information questions. To the Japanese, Masuda said, IBM represents the pinnacle of computer superiority.

"Our national strategy in computers has always been to match IBM," he said. "Now we have changed. Instead of equaling IBM, we want to develop new technologies."

All participants in the fifth-generation project will share in its success, Fuchi said. France and Great Britain have expressed interest in helping. Neither the U.S. government nor IBM has done so.

"I hope IBM will change its basic philosophy," Masuda said. "Of course they should have their own long-range strategy, but they also should look at their worldwide responsibility in the information-processing arena."

Is the project realistic? The Japanese government is convinced it is. So are the country's electronics giants, who expect to use fifth-generation technology to create vast new families of computers and related products.

Yoneji Masuda isn't so sure. He does foresee versions of the new computer expertly managing robot teams along production lines, changing daily life through improved communications and information flow, and handling such assignments as medical diagnosis. But he fears the rest may still be a dream.

"I think it all may be too ambitious," he told me. "It may not yet be possible to get humanlike association in a computer. It requires too much memory, too much logic. But still, it must be started." ■

Smokey's amazing 150-hp, 2-cylinder engine

In theory, Smokey's use of waste heat should cause the engine to destroy itself

By E. F. LINDSLEY

ILLUSTRATIONS BY RAY PIOCH

DAYTONA BEACH, FLA.

The transmission was stuck in high gear. Traffic on the cross street was heavy. Getting across would require a quick start and a fast sprint through a hole in the rush-hour flow. Smokey glanced both ways and said, "Do it!" I nailed the throttle, and much to my surprise—and relief—we shot through a break into Yumick's yard on the other side. Why surprise? The engine under the hood had only two cylinders.

I had come to Smokey's garage to see and drive this remarkable new engine. At first, I was skeptical; the claims seemed outrageous:

- It's so smooth it feels like an electric motor.
- It gets 60 miles to a gallon, with more than 150 horsepower on tap.
- It meets 1983 emission standards easily without any electronic controls.
- It has incredible low-end torque.

What I found was a two-cylinder engine that's smoother than most fours, with torque and horsepower similar to those of a V6. Its secret: Most engines throw away an astonishing 75 percent of the potential heat in the fuel they burn. Smokey has found a way to recapture much of that and put it back to work. While engineers have long known that this was theoretically possible, there were practical difficulties. Smokey has apparently found a way around the problems. As a result, auto-company engineers and ex-

ecutives are flocking to Smokey's garage here in Daytona Beach, Fla., trying to discover his secret. To date, they've learned only part of it. Until his patents are issued, I learned on my recent visit, he's not telling anybody about a few of the key developments. But I did learn enough to tell you in general what this remarkable new engine does and how it does it.

The first thing that strikes you about this engine is its size. "Seventy-eight cubic inches and 170 pounds," says Smokey. It's a small V2, conventional in many respects. But there is quite a bit of extra plumbing. Surprisingly, there is no cooling fan, and Smokey says there are only two quarts of water in the entire system, including the tiny radiator.

Smokey calls it his "Phase I adiabatic engine." Adiabatic is an engineering term that refers to any process in which there is no gain or loss of heat. A completely adiabatic engine is not possible. But the closer you come, the higher the engine's efficiency and the better the fuel economy. To put it another way, the less heat energy generated by the burning fuel that you throw away through the exhaust and cooling systems, the more you put to work moving the car.

The secret's in the plumbing

Despite its obviously sophisticated engineering, the engine is surprisingly simple. Don't look for exotic materials, novel mechanical linkages, or unique structures; you won't find them. Although this experimental engine is hand-welded from aluminum, that's not the way a production unit would be made. It was simply a quick and easy way for Smokey to create a two-cylinder. The accessories, including the carburetor, are mostly pick-

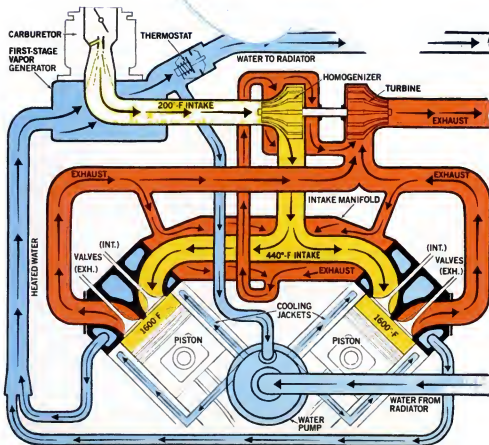
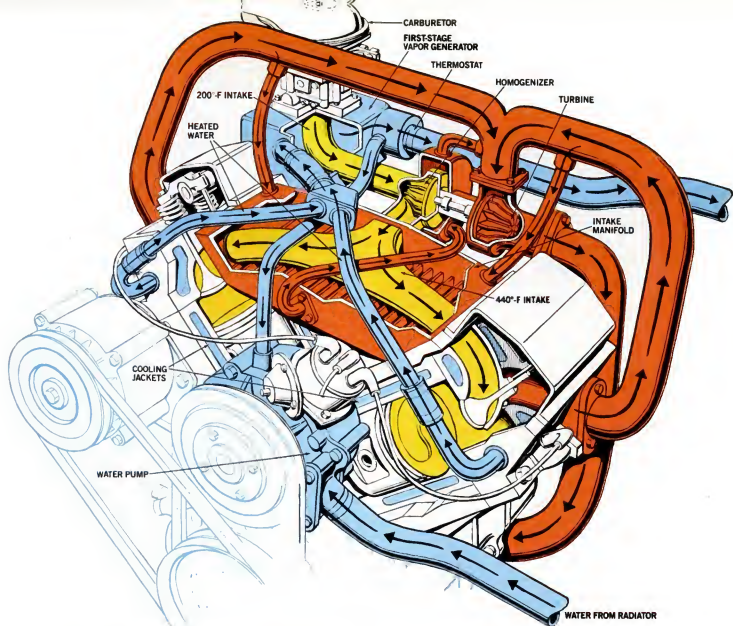
ups from around the shop. There are no electronic devices. Smokey prefers to avoid them, so his engine runs with a simple carburetor and breaker points. Yet it meets all emission standards.

The secret of the engine's remarkable performance is its unique three-stage heat-recovery approach, which accounts for the strange-looking plumbing. In essence, Smokey uses part of what would be waste heat in a conventional engine to preheat the air-fuel mixture before it reaches the cylinders for combustion. To see how it was done, I traced the cooling-jacket outlet lines from the cylinder heads to a boxlike structure under the carburetor. Smokey calls this the first-stage vapor generator. All of the air-fuel mix from the carburetor passes through it and is heated to over 200 degrees F, increasing fuel vaporization for smoother operation. At this point, Smokey begins to cut across the grain of accepted induction and combustion theory, or at least he writes a new chapter: Normally, intake-charge temperature rarely exceeds 130 degrees F.

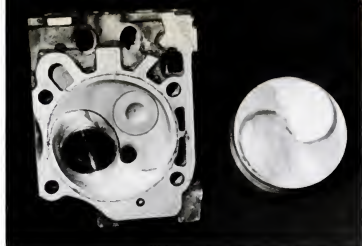
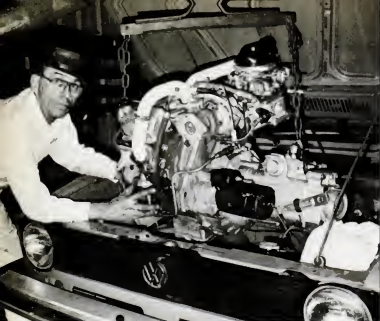
But Smokey has a second innovation—the small turbocharger he insists on calling a homogenizer. The compressor side of this unit is jacketed with a metal envelope. A pipe from the exhaust system vents hot gases into the envelope. That heats the intake charge even further. Smokey's engine introduces a hot charge into the chamber, so there's less chance for the mixture in contact with the walls to cool below its burn temperature.

The third and final preheating takes place in the intake manifold. Smokey describes it as "a shell over a

Continued



Smokey's Phase I adiabatic engine heats the air-fuel mixture for greater efficiency. The mix enters a boxlike jacket—the first-stage vapor generator—below the carburetor. Hot water from the small cooling area surrounding the upper 2½ in. of the cylinders and the cylinder head is pumped into the first-stage vapor generator by the water pump. From there it goes to the tiny radiator. (When the engine is cold, the thermostat directs the water back to the water pump via a bypass line.) The mixture leaves the generator at about 200 deg. F. The second heat addition occurs at the homogenizer side of the exhaust-driven turbo, where hot exhaust gas is piped into a jacket surrounding the housing. Still more heat is added, also by exhaust gas, when the charge passes into the jacketed intake manifold. At this point the mixture has reached a temperature of 440 deg. F.



Engine-transmission package is lowered into a Volkswagen Rabbit test vehicle by Smokey. The bulk of the load is the transmission; the engine itself is dwarfed by its own induction system. Yunick's "yin-yang" piston and cylinder head (above) are the result of swirl-mixture testing in a transparent test cylinder.

shell, a heat exchanger, or a super-heater." By the time the mix passes through the heated manifold, its temperature has reached 440 degrees F.

This is where Smokey reveals the second function of the homogenizer. "When the intake mix confronts these high temperatures, it begins to expand. The tendency without the homogenizer would be to back out of the carburetor. It's the homogenizer's job to hold about half a pound of pressure on the manifold. It acts as a sort of one-way valve."

Smokey described his experiments with fuel vaporization: "On the flow bench and on the dynamometer we'd pull out a sample of air-fuel mix from the carburetor, and you couldn't punch a stopwatch fast enough before it started separating into liquid fuel and air again. But when it goes through the homogenizer, it's 20 minutes before it starts settling out."

Perhaps this thorough mixing and vaporization are part of the reason Smokey's engine operates with such low emissions. Unburned hydrocarbons and carbon monoxide are major pollutants. They are caused primarily by two things: charge stratification and surface quenching.

Stratification occurs when the fuel mixture separates into distinct lean and rich combinations or layers. The homogenizer prevents that by creating a uniform concentration of fuel in the charge. Surface quenching occurs because the temperature of the combustion-chamber wall is lower than that required for combustion. This cools the mixture in contact with the surface below its burn temperature. Combustion remains incomplete and the unburned hydrocarbons are expelled with the spent gases.

At this point, what everyone, including the major car companies, would like to know is why Smokey's engine doesn't destroy itself via ab-

normal combustion, called detonation. Any automotive engineer can tell you that detonation occurs when either the temperature or the pressure in a combustion chamber is too high. Inside the hot chamber, reactions become so rapid that uncontrolled, often destructive combustion begins to occur in parts of the chamber rather than smooth, progressive burning. These rapid reactions produce high-frequency pressure waves that beat against the combustion-chamber walls, causing the vibration we hear as knock or ping.

Any engineer can also tell you that the high-temperature mixture in Smokey's engine would cause severe and damaging detonation. The only way to reduce the tendency toward this condition would be to reduce temperature and pressure or to use high-octane fuel. Yet Smokey defies commonly accepted thermodynamic theory by adding heat, pressurizing, and running on regular unleaded gasoline. And it doesn't knock.

Why not? Smokey says that's the heart of his patent, which has still not been issued. Until then, his attorney has advised him not to talk. In fact, during my visit he called his attorney three times to check on just what he should—and shouldn't—say.

Excited executives

Smokey's contradiction of all conventional theories on detonation and fuel behavior has stirred enough excitement to bring top executives and engineers from Ford, GM, and Chrysler, as well as from several foreign builders. "We've had top-level people from GM, Ford, and Chrysler actually drive the car," he says. Smokey says he's turned down checks for as much as \$200,000 for short-term options.

Smokey's problem with these contracts was the unwillingness of interested companies to commit to paper or

even discuss financial considerations, if they did indeed decide to use his technology. He also says that he has no confidence that his patents are sufficient protection. "The only protection I have going for me so far is the fact that nobody knows how the system works. I've been careful not to explain it, although it's really quite simple. What keeps them coming back is that they can't make it detonate."

How did the visiting experts try to do that? Smokey told me that some had lugged the car down to 20 mph in top gear, with a tall final drive, and floored the accelerator. They had even tried turning the engine off, then restarting and flooring it. Others took it up to 80, 90, and even 100 mph and listened—to no avail. Smokey told me how one engineer had been trying to make the engine detonate for 3½ hours without success. He wouldn't believe how hot the manifold was and finally put his hand on it. He got a third-degree burn.

One engineer from a European car maker was checking the engine on the dynamometer in Smokey's lab. After observing a healthy 100 ft.-lbs. of torque at 1,200 rpm, he asked Smokey how fast he could safely run the engine. "You can take it to 5,000 rpm if you want," Smokey replied. "There it'll make 150 horses." The engineer ran the engine to 4,400; the needle showed 165 ft.-lbs. of torque. "Do you realize that's as much as our turbocharged five-cylinder?" the amazed engineer asked.

Smokey has built one-, two-, three-, and is currently working on a four-cylinder adiabatic engine. He notes that the big car companies don't seem interested in the one-, two-, or even three-cylinder. He doesn't see the reason. After all, he points out, "The two puts out 150 horses at 5,000 rpm; the 125-cubic-inch three produces 240 hp

(Continued on page 168)

Gigantic Dutch project: sea storage for wind energy

Teaming windmills and dikes, the Dutch aim for energy independence by the year 2000

By DAVID SCOTT

ILLUSTRATION BY JEFF MANGIAT

THE HAGUE, NETHERLANDS

One day a Dutch yachtsman sailing on the IJsselmeer may tack to avoid a huge sloping wall looming out of the water. Rising 92 feet above the surface of this vast lake reclaimed from the North Sea, the wall encloses a huge, 64-sq.-mi. reservoir, three times the area of Manhattan. The energy generated by a thousand towering windmills is stored here.

Piercing the sky above Holland's wind-swept coast, each whirling mill feeds electricity into the national grid (see illustration, next page). Some of that electricity powers turbines set in the base of the IJsselmeer wall—really part of a massive dike ringing the reservoir. An enormous storage tank for wind power, the reservoir produces hydroelectricity when the winds fail.

This is Holland's Wind Energy and Electricity Storage Basin Project, an audacious scheme that taps renewable energy resources on a breathtaking scale. I recently visited Holland to learn the details.

The idea was hatched in 1979 by Lukas Lievense, a Dutch engineer. Holland's annual oil bill for electric power plants was set to rise sharply. Environmentalists had halted construction of nuclear power plants, and meager sunshine ruled out a solar alternative.

Wind? There's plenty of it sweeping over the flat land. But Holland's

winds are erratic, alternating fitfully between big blows and dead calms. Linking clusters of giant windmills to a backup storage system could solve that problem, Lievense figured. And what better system for Holland than hydraulics?

Lievense's scheme combines two areas of traditional Dutch expertise: wind and water. For centuries, dikes have reclaimed Dutch land from the sea and windmills have pumped it dry. The colossal Delta Plan flood-control project (PS, Feb. '82) is Holland's latest triumph of hydraulic technology.

So the Dutch government took Lievense's ambitious proposal seriously, creating a study group to explore the project. Gerrit Plantema, to whom I spoke in The Hague, heads the group.

Meeting peak loads

"The full project will take 15 years to complete and cost \$5 billion," Plantema told me. "But by the year 2000 it will produce 3,000 megawatts directly from the wind, plus 2,400 megawatts of hydro energy."

"That's enough energy to handle all of Holland's daily peak loads," Plantema continued. "Because we need to keep auxiliary plants on standby to provide for peak loads, it's presently the most expensive electricity to produce."

What would Lievense's plan entail? In his Hague government office, Dirk Zwemmer, one of Lievense's engineers, explained the scheme to me.

First, the windmills. Each 262-ft.-high tower with its equally large two-bladed rotor will generate three MW. Lievense plans to mount the towers in groups of 350 at three wind-swept locations, Zwemmer told me. One group

would line highways leading into the Rotterdam port complex. Another array would march along the northern coast. The third would go up near the proposed storage reservoir.

"All the windmills in each group could simultaneously feed electricity into the grid," Zwemmer said. A solid-state rectifier-inverter would merge the output in DC state from separate windmills, stabilizing the voltage then setting the AC frequency to precisely 50 Hz, the European standard.

Excess power generated by the windmills would flow through the power lines to turbines at the giant pumped-storage reservoir.

Pumped storage is nothing new, though so far it's been used only in naturally hilly areas with upland lakes. For billiard-table-flat Holland, Lievense would use man-made dikes to lift a reservoir high above its parent lake.

He thinks the IJsselmeer, the former Zuider Zee, is ideal. This man-made lake is already divided by a long dam built for future land reclamation. That span could form one wall of the wind-power reservoir. A new, curved dike will enclose the water pumped up by hydroturbines.

Zwemmer described the proposed storage basin to me. Torpedo-shaped turbines will be mounted in three arrays of 16 along the dike's base. "When the windmills produce more energy than needed, the surplus drives these submerged Kaplan turbines as motors," he said. "Their variable-pitch blades are angled for pumping, so they suck water out of the lake to raise the level in the reservoir."

The reservoir could loom as high as 82 feet above the lake's surface,

Continued

Zwemmer said. "During wind calms, this head of water would be released to spin the turbines. With blade pitch reversed, the machines would run as generators, feeding electricity into the national grid."

The scheme has progressed beyond the stage of maps and drawings. The Netherlands government has given the go-ahead to a pilot scheme at Petten, north of Amsterdam.

Rising 72 feet above the sand dunes, the Petten windmill has an 82-

ft-diameter downwind rotor. Precision controls provide near-constant rotational speed to the windmill's 300-kW generator, which provides power to the local AC grid.

Equipment at this research site checks aerodynamic behavior of the blades, monitors the forces bearing on the concrete mast and foundation, and records structural vibrations.

The lone windmill at Petten is the product of five years' research. Soon, 20 more like it will rise at a similar

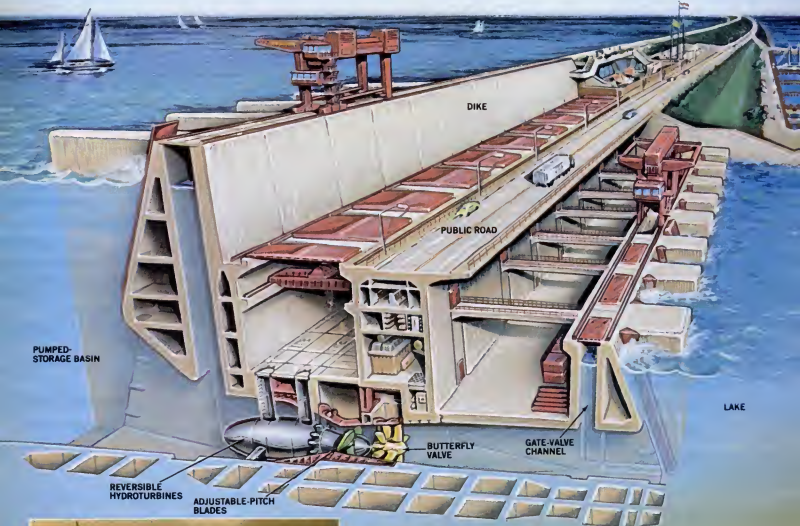
coastal site. This government-sponsored wind station is scheduled for construction early next year. Experience gained from the experiment will determine the next step.

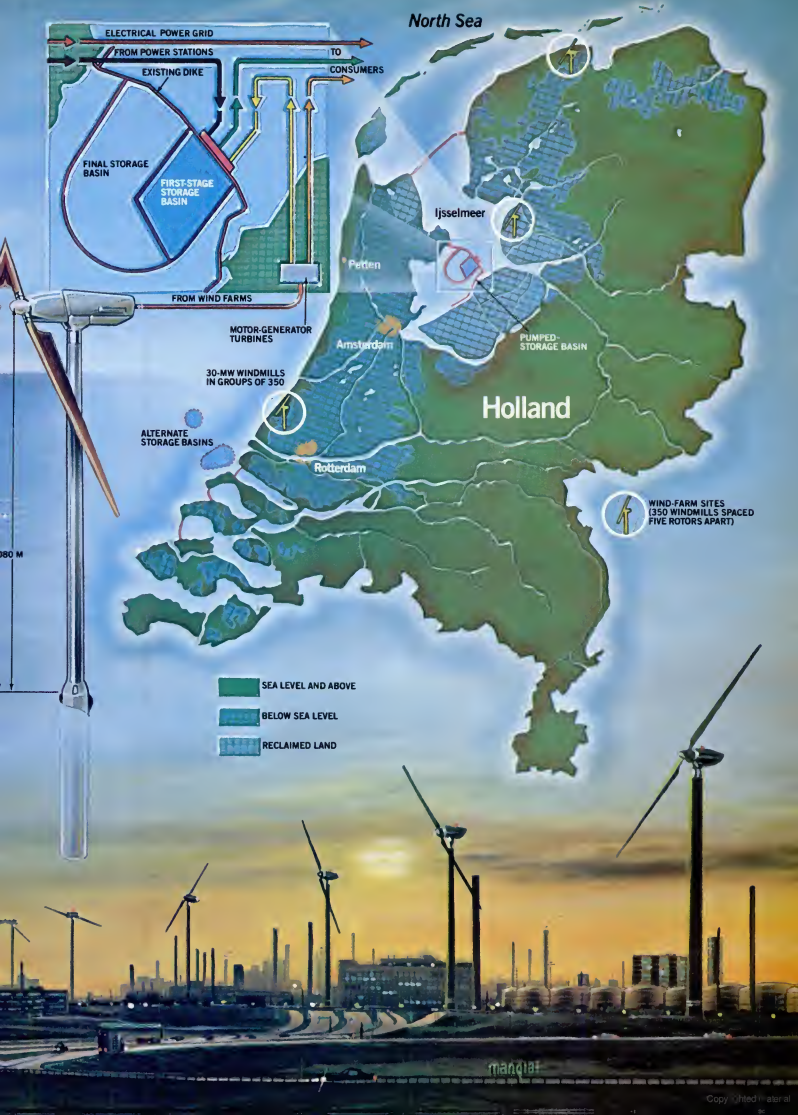
Though not all Dutch citizens share Lieve's grand vision, his giant-windmill scheme is likely to materialize in some form. The final decision will be made in 1985. Hydraulic energy storage could then be only a step or two ahead, for little Holland is a think-big nation. **ENR**

Giant windmills pierce Rotterdam's skyline (below, right). The array is one of three huge wind farms planned for Holland by the year 2000 (map). An experimental windmill now operating at Petten (inset) is one-tenth the size of the planned three-MW version below. Grouped on a common power line, the windmills feed

electricity directly into the national power grid (schematic, right). At off-peak times, wind-generated electricity flows to 48 turbines at the base of the IJsselmeer Dike (map). In its final form, the dike will enclose 64-sq.-mi. reservoir. The Kaplan turbines (illustration below) pump water into the reservoir until the wind fails. Then the

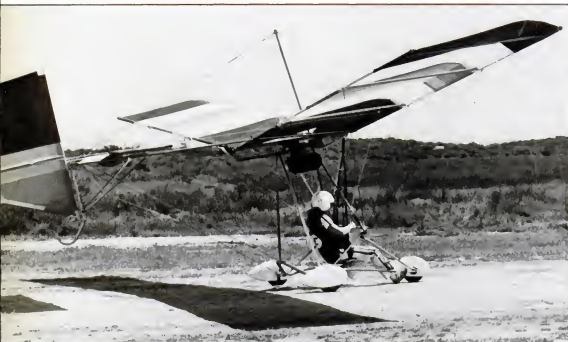
flow reverses and the turbines generate electricity, producing 50 MW each. When turbines aren't pumping, butterfly valves seal off input channels to maintain water level in the reservoir. Gate valves, raised and lowered by cranes, isolate the turbines for drydock servicing. System will produce 12 percent of Holland's power.





What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



Bright lamp

Krypton gas surrounds the bulb in the Krypton-Lite eight-cell flashlight, permitting a higher filament temperature and dazzling brightness, says Tekna (Box 2363, Menlo Park, Calif. 94025). A new lens concentrates its 18,000-candlepower beam.

Trim ultralight

Lean forward or back and a "trimvator" control in the Quicksilver "E" ultralight helps you change the aircraft's angle of attack. The pitch-control devices are on both sides of the stabilizer. Eipper-Formance (San Marcos, Calif.) makes the 20-hp, \$3,645 craft.



Convertible coupe

New interest in open vehicles is drawing attention to Talbot's Samba Cabriolet, says the maker. Italy's Pininfarina strengthened the Samba saloon car with a reinforced floor and roll bar. Drag coefficient: 0.38 (top closed) and 0.45 (open). It is sold only in Europe.

Digital thermometer

A palm-sized electronic thermometer from Germany measures temperatures from -55 to 150 deg. C (-67 to 302 F) with an accuracy of 0.2 deg. A built-in lamp aids darkroom work. It's from Ebro Electronic GmbH, Peringer Str. 10, 8070 Ingolstadt, Germany.

Slim battery

Polaroid has brought the longer shelf and service life of lithium cells to games, calculators, and compact radios with its P500 Powercard. The slim, playing-card-size, six-volt battery has a capacity comparable to four conventional AA alkaline batteries, says the firm.



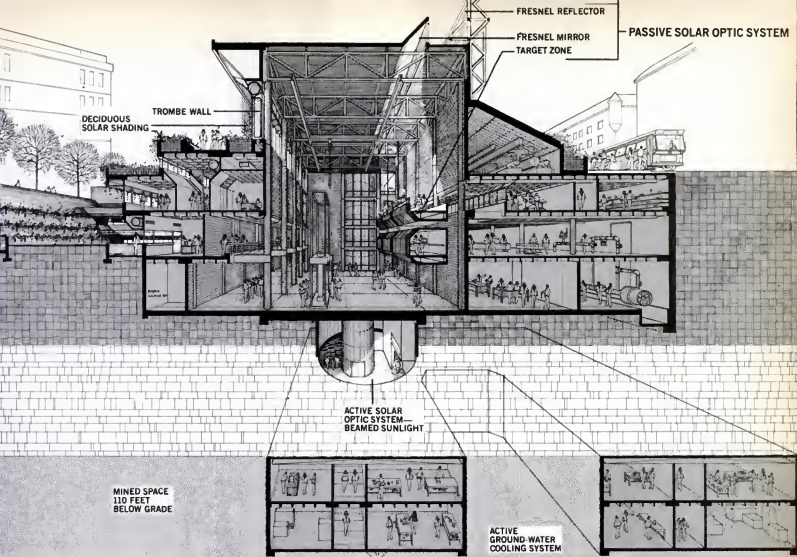
Halogen bulb

A 90-watt spot or flood lamp with the same beam performance as standard 150-watt lamps: That's the result of high-density halogen gas in its new PAR bulbs, says General Electric. GE developed a new glass to encapsulate the tungsten filament instead of using costlier quartz.

Anti-theft briefcase

A buzzer sounds in your pocket transmitter if someone moves this briefcase more than 15 ft. away. Then an alarm goes off in the bulletproof case, and a nonfatal 2,000-V shock forces the thief to drop it. Hammacher Schlemmer, 147 E. 57th St., New York, N.Y.; \$7,500.





Happier landing

This rocket-ejected parachute for hang gliders gives a safe landing from a height as low as 70 feet, claims Ikarus GmbH (Tannenweg 20, 7031 Aidlingen/Wurt., Germany). The pilot deploys the 37-ft.-dia. chute electronically.



Weatherproof lock

Cover-all padlocks are protected from ice, mud, and salt corrosion, says Dale Hampton Co. (Box 27006, Denver, Colo. 80227). Tough plastics cover the shackle and two-piece case. The snap-on cover ensures that lubricants won't attract dirt. The 1½-in. lock costs \$7.98.



Double winglets

An unusual turboprop pusher plane being tested near Reno, Nev., sports updated winglets. Lower winglets are canted outward 36 degrees, weigh 30 pounds less than earlier ones ("What's New," PS, July '81). New design for the OMAC may eliminate earlier wing-twisting problem.

Low-cost windmill

A 42-inch wooden rotor is connected directly to a low-rpm generator on Windstream. The \$329 wind generator delivers 25 watts of power in 15-mph breezes. An automatic overspeed control cuts in during high winds. Thermax, One Mill St., Burlington, Vt. 05401.

Buried lab

University of Minnesota civil and mineral-engineering students will personally experience energy conservation while they learn in this buried lab. BRW Architects of Minneapolis combined earth-sheltered upper floors with rooms built into space mined 110 feet beneath the surface.



What's New



Mini-drone

Too big to be a toy, the radio-controlled CAP 20L kit plane has a 6.75-ft. wingspan and weighs 20.5 lbs. A two-hp modified Homelite chain-saw engine powers the fiberglass craft for about a half-hour flight at 65 mph, says Contempo Hobby (1611 Cantara St., N. Hollywood, Calif. 91605), \$349.



Plastic bike

Rain can't rust the Ranger, and scratches won't mar its finish. The bike's molded, glass-reinforced-polyester frame is more rigid than welded tubes, claims the French maker, Renault-Gitane. Nylon-fiberglass wheels and ABS mudguards help keep the bike at 22 lbs. It's not available here yet.

Scooter trucks

Both the mini-bus (top) and the pickup versions of this three-wheeler get 67 mpg and handle an 800-lb. payload, says Bajaj America (1237 Gadsden St., Columbia, S.C. 29201). The made-in-India rear-drive vehicle has a 10-hp engine and steel unit body. Prices start at \$2,695.



Wind-tunnel test

No, the Mercedes hasn't crashed into a giant propeller. The knife-like fingers are smoke jets that show airflow inside a wind tunnel. The test measured drag caused by car-topped surfboards. Finding: They should be stacked and carried as far back as possible.

Wristwatch radio

Dick Tracy might curl his lip—it's just a one-way (AM) radio—and you need an earphone to hear it clearly. But the digital watch also shows day and date and has an alarm mode. Price: \$62.95 from I.M. Simmons, Box 604, Hastings, Fla. 32045.



What's New IN BOATING

BY SUSAN RENNER-SMITH



Cockpit caddy

No more spilled beer, wet charts, and missing winch handles. Each Sea-Tray holds two cans and other cockpit essentials. The plastic tray has UV inhibitors to prevent cracking. Price with rail clamp: \$13. United Yachting, 23230 Tireman Ave., Dearborn Heights, Mich. 48127.



Dry box

Soggy crackers in the galley? Mildew in the hanging locker? The Hydra-Pex portable dehumidifier absorbs humidity for up to three months, says Hamer Products (4100 Cassandra Lane, Plano, Tex. 75075). When the absorbent crystals are saturated, a refill renews it. \$30.



Mini-radar

Compact enough to fit aboard a 25-footer, the Vigil radar has an 11-lb. display unit with a digital readout. The 21-lb. scanner (not shown) is two ft. in diameter. For radar, it's also inexpensive—\$1,650. Mars Marine (266 Bath Rd., Slough, Berkshire SL1 4EB, England) makes it.



Swift cruiser

Its canoe-shaped, wood-and-epoxy hull is lighter yet stronger than fiberglass, says Norton Boat Works (Green Lake, Wis. 54941). The rotating masts carry efficient, fully battened sleeve sails. Result: The 44-ft. cat ketch speeds downwind without a spinnaker, says the maker. \$130,000.

Ladder cart

Trundle provisions to the dock with ShipMate, then use it to climb aboard. Rot-proof straps suspend it from boat fittings; the dolly rack holds it away from the hull. Remove wheel cotter pins, and the \$195 unit folds flat. Roca International AB, Norrlandsgatan 16, S-111 43 Stockholm, Sweden.

Fender holder

No more dragging fenders out of lockers—or tripping over them on deck. Each stainless-steel caddy stows up to six 10.5-in.-dia. fenders. The caddy hooks to round rails with 60- or 90-deg. stanchions. Price: \$246 a pair for the large caddy. Growler Marine, Box 35139, Minneapolis, Minn. 55435.



What's New

IN TOOLS

BY V. ELAINE SMAY



Cordless scrubber

You'll put power behind your cleaning (wet or dry) with the rechargeable \$45 Scrub Brusher from Black & Decker. With one large and one small brush, it cleans grime from tile grout, whitewall tires, brick walls, barbecue grills, and more. A charge lasts 30 minutes.



295-lb. plane

It'll never get off the ground (in this case, that's good), but it will make the chips fly. The RC-33 planer is rugged enough for production runs, says Rockwell Intl., but priced for the home workshop (\$1,900, as shown). It takes stock from 1/4 to 5/8 in. thick and up to 13 in. wide.

Add-on edger

Toro's \$20 edging attachment (inset) bolts on in place of one front wheel on any Toro front-wheel-drive, self-propelled, walk-behind mower—such as the model 20773 (\$500) shown. The 10-in. blade of The Edger turns at a very slow speed and cuts to a depth of 1 1/2 inches.



Brush bathtub

A clip ring in the Brushtub suspends up to six paintbrushes in cleaning solvent, allowing paint to drain to the bottom. The lid seals tightly to reduce evaporation, odors, and spilling. Newell Furnishings Ltd., Spennells Valley Rd., Kidderminster, Worcester DY11 1XS, England.

Shop "trifecta"

You'll win three ways with the All Horse, says Wen: It's a sawhorse, workbench, and vise. The seven-by-29-in. top has 14 holes so you can position the two stops and ram vise where you need them. All Horse is 28 in. high, costs \$38, folds (and hangs up) for storage.

What's New

IN HOME IMPROVEMENT

BY SUSAN RENNER-SMITH



Light stretcher

The Bulb Saver extends a bulb's life without dimming it, says Piezo Electric Prod. (212 Durham Ave., Metuchen, N.J.). Unlike diodes that cut voltage—and light—this thermistor's high resistance controls the initial power surge. When it's heated, resistance plunges and brightness returns. Three for \$4.95.



Storage bin

An organizer's delight, the polyethylene Pour 'N Store bin helps unclutter work spaces. It holds 40 lbs. of seeds—and more of denser dry material. A pull-down handle dispenses the contents through a bottom chute. From D.R.I., Box 20612, Bloomington, Minn. 55420; \$23.89.



Awning protector

Coordinating signals from sun and wind sensors, the Somfy-Matic commands motorized awnings to extend or retract. The \$399 electronic controller can manage all awnings (or motorized solar shades) on one side of a building, says Somfy (2 Sutton Pl., Edison, N.J. 08817).



Closet safe

Safe-T-Closet converts an ordinary closet into a vault. The pre-hung steel door screws into an existing wood frame. The combination deadlock has an inside safety release. The 2.5-ft.-wide unit is \$340. General Products (Box 7387, Fredericksburg, Va. 22404) makes two other sizes.



Earth anchor

Once its aluminum anchor is pounded into place, the Duckbill will hold down 7,000 times its own weight, says Foresight (Box 4067, Cheyenne, Wyo. 82003). Safer than earth anchors with protruding pipes or stakes, the Duckbill exposes only the cable-end loop.

Budget solar wall

Assembled from mass-produced Solarwall modules, this collector costs about \$13 a sq. ft. The die-stamped, two-ft.-sq. black aluminum absorber plates interlock; you top them with glass, then mount them on a south-facing wall. Maker: E.R.I., Box 707, Novi, Mich. 48050.



What's New

IN ELECTRONICS

BY WILLIAM J. HAWKINS



A kit robot to teach you robotics

He's called the Heath Educational Robot—HERO, to his friends. He walks (actually, he "rolls" on three wheels), talks (with a synthesized voice), and uses his electronic sensors to detect light, sound, motion, and obstacles. His head, arm, and hand can be moved in any position for a variety of tasks—such as handing you his \$99 optional course book on robotics. A built-in microprocessor makes him programmable; a built-in battery makes him independent. HERO 1 is a \$1,500 kit (\$2,495 assembled) from Heath Co., Benton Harbor, Mich. 49022.



Auto azimuth

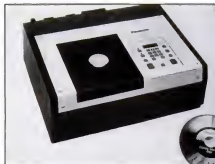
Tape-head azimuth—the angle at which the head tracks a tape—is critical. Most decks are preset; a few are adjustable using a specially recorded signal. But for perfect alignment, the Nakamichi Dragon adjusts itself to the tape you are playing. It's \$1,850.

Disc recorder

Panasonic's laser-disc unit can show any of 15,000 picture frames stored on that eight-in. videodisc in 0.5 second. What's so new about that? This system also records. It replaces conventional storage devices such as microfilm and slides. Price: not yet set.

Two in one

Turn on the Franklin Ace 1200 personal computer, and you can use either Apple II or CP/M software—it accepts both. The basic unit comes with a single disc drive, 128K of RAM, and two interfaces for connecting external gear. It displays 80 columns per line and color graphics. \$2,495.



Portable player

Hi-fi on the go usually means a portable cassette player. Not with Mister Disc by Audio Technica. It's a portable LP- or 45-rpm-record player. Three C cells power it, and the stereo earphones included produce high-quality sound. The four-by-11-in. unit weighs 2.5 lbs. It's \$170.

Smart terminal

Turn on the Scanset XL terminal, and it displays 36 phone numbers. Choose one—at the push of a key—and Scanset automatically dials a remote computer and enters your password. Its built-in phone lets you call humans, too. Tymshare, Cupertino, Calif. 95014; \$895.

What's New FOR YOUR CAR

BY JACK KEEBLER



Slim tach

As cars get smaller on the outside, dash space shrinks, too. The Slim Line tachometer is only 7/8 in. thick, 3 1/2 in. wide, and 2 1/4 in. tall. Accurate to 8,000 rpm, it comes with all the mounting hardware. Sun Electric Corp. (1560 Trimble Rd., San Jose, Calif. 95131). Price: \$39.45.

Ping control

The Engine Knock Eliminator monitors engine-damaging ping and automatically adjusts timing for top fuel efficiency without harmful detonation, claims Carter Automotive (9666 Olive Blvd., St. Louis, Mo. 63132-3086). Price: \$114.55.



Electric pop top

Its glass panel is designed to tilt upward as it slides open. According to Hollandia-Sunroofs Inc. (10080 Sumac Circle, Eden Prairie, Minn. 55344), this spoiler effect improves airflow and keeps wind noise to a minimum. The frame is aluminum and stainless steel. \$159.



One-piece ramps

They're rated for up to 6,500 lbs., says Petersen Automotive (400 Wheeler Ave., Fredonia, Wis. 53021). That makes Bear-Claw ramps safe to use with cars and even small trucks. They feature built-in pavement grippers, double-plate welded-steel corners, and contoured wheel wells. \$19.95 a pair.



Bumper fixer

Torn or gouged black flexible bumpers can be restored with this repair kit, says Dynatron/Bondo (2160 Hills Ave. N.W., Atlanta, Ga. 30318). Price of the nine-piece kit: \$11.40. For reconditioning bumper appearance only, a two-piece package of Coating & Conditioner and Buffer/Cleaner (\$5.80) will suffice.

Easier jumps

You won't have to raise the hood for a jump after you bolt the short cable to the service vehicle's battery and snake the plug-end through the grille. Clamp the second set on the dead battery, and unite the 30-ft. cable. Goodall Mfg. (7558 Washington Ave. S., Eden Prairie, Minn.), \$79.



Wheel-cover lock

Drill a hole through a hubcap, and you can attach the Caplock I guard. A lock outside attaches to a stem secured to a bracket on the wheel. Coventa Agencies, Inc. (1341 Newton St., Boucherville, Quebec J4B 5H2), sells it: \$21.95 for four.



You can transform a tract house

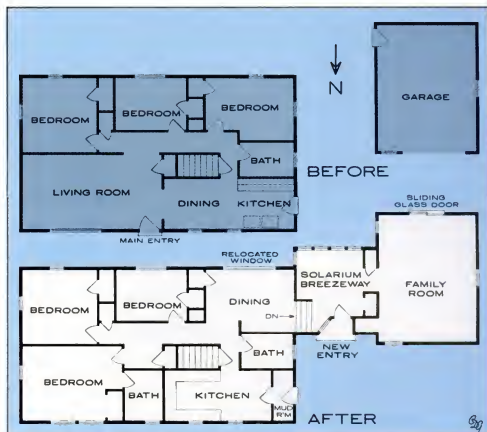
Following this pro's lead, any ranch-style house with detached garage can become a solar showplace

By AL LEES

Seldom has a remodeling job accomplished this much. When I first saw this house—and its before-and-after floor plans (right)—I knew it was a story *POPULAR SCIENCE* should tell. The transformation is far more than cosmetic: The entire character of the house has been changed from drably functional to excitingly spacious. As an important bonus, window-siting errors were corrected and additions made that greatly improve the home's energy efficiency.

Even if your present home isn't as uninspired as this one was, you can probably adapt many of the ideas detailed here. Some of them may look familiar: I first saw this project on the PBS television series, "This Old House," hosted by Boston renovator Bob Vila (see this issue's "Shop Talk"). Normally, the show deals with the restoration of antique houses—not a do-it-yourself area of interest to PS, the "What's New" magazine. But when I learned last year that Vila was tackling a 1950s ranch-style house familiar to thousands of our readers, I felt his many improvements were too shrewd to leave to the limited exposure of educational television.

First of all, note that the floor-plan orientation switches from *layered* zoning (with privacy areas—bedrooms and bath—at top, and public space—living, dining, kitchen—below) to *vertical* zoning (with private rooms to the left, public to the right). In a house this size, vertical floor-plan zoning is



Compare floor plans above with photos on facing page. Only new structure is breezeway to connect house with unused

garage. Converting garage to family room then creates new wing that wholly alters zoning of private and public areas.

more practical for simultaneous dual function: Family members or house guests can retire for the evening while group activity continues in the other area.

As with so many quickly built, cheap mass-market houses of the postwar era, access to this home was through ill-planned doors that swung directly into living space. Not only was that awkward; it was energy-wasting since heated or cooled air was vented directly outside each time either the main entry or side door was

opened. In the revised floor plan, that dead-center main entry was sealed (the top part of its opening became the bathroom window) and the main entry was moved to the new breezeway. The side door into the kitchen was retained, but since the kitchen was doubled in size (by absorbing an adjacent, undistinguished dining area), it was practical to tack on a mud room-pantry that serves as a kind of entry air lock. This side entry is totally restyled, with its stoop compressed and

Continued



Most dramatic face lift is along north walls. "Decorative" shutter slats were scrapped and surfaces re-sided with same

natural-finish vertical boards used as siding on breezeway. Garage-door entry was sealed into energy-saving solid wall.

Home's canopied front door moved from dead center of wall to center of new breezeway, with privacy screen added.



Connecting structure changes character of entire house. Foundation of new solarium is concrete slab laid on grade, so it's at same level as garage floor. Old corner bedroom becomes dining area, with arched opening cut in outer wall through which stairs descend from original floor level. Note relocated picture window behind dining table. Solarium (right) has quarry-tile floor. This is now home's main entry—and first impression.





Old garage walls are finished off with drywall, pierced with new windows; rafters and tie beams are closed with wood strips.

Spacious new kitchen has room for breakfast table and improved triangular placement of the sink, range, and refrigerator.



its stairs turned 90 degrees to climb along the wall. A new screen wall provides privacy from the street for both entries and deflects gusty winds from this entry patio.

One of Vila's shrewdest alterations was shifting that picture window from the north wall—the street facade—where it not only got no sun but also compromised the privacy of the living room. As the top-right photos show, it was simply carted around back where it contributed to the solar gain—and gave the new dining room a view of the wooded area out back. Its old opening was partially closed up (and, of course, insulated) for the installation of a new wide but shallow double-glazed window, to provide better privacy for the master bedroom that replaces the living room at the front corner. (A second window was added around the corner.)

The prize of Vila's remodeling, however, is the recreational suite added on the home's right end. By insulating and finishing off the detached garage and joining it to the house by means of a tile-floored solarium, he created not only a gracious entry but an activity area larger and more inviting than the discarded living room. The house is no longer a cramped box, and its architectural interest is greatly enhanced, both inside and out. To bridge the distance between existing structures without adding support posts, Vila created a massive ridge beam of four 2x12s. He also beefed up the vertical framing in the existing walls to handle the transfer of load from the new roof.

The alterations also increased the home's efficiency through better siting of the windows for solar gain. The solarium, facing south, is an especially good passive collector. Its quarry-tile floor is laid over an eight-inch concrete slab atop a foot-deep bed of crushed stone. Rigid two-inch foam insulates the footings to a depth of two feet. This heat sink soaks up and later radiates heat from solar exposure. If insulating drapes were drawn across the panels of glass at night, the heat stored in the slab should keep the area cozy on all but the most severe winter evenings. For those, it might be best to close this area off from the family room—and draw an insulated drape across the sliding-glass door there, as well.

The entire remodeling project was budgeted at \$25,000—including all new appliances for the kitchen and a wood-burning stove for the family room. The remodeling took longer than the original construction: This house was just one of 400 tract homes thrown up by a Boston developer in



Out goes the picture window from the front of the house. It was simply removed as a unit and carried around to the oppo-



site corner, at back, where it was installed in rough opening framed to take it (photo above; note corner of garage at left).



Concrete is dumped between new block footings connecting garage to house. Once slab cures, breezeway structure is



erected on it (right). Breezeway's ridge beam is tied into garage roof at far end and into cutaway wall in foreground.



The bridging breezeway is two-faced, providing new entry for front of house (left) and heat-capturing solarium for



south-facing back (above; new windows in former garage at left are same as seen in color interior at top of facing page).

the mid-1950s. On average, he finished two a day, each house taking seven weeks from start to finish. What a contrast with today's home-building pace!

With new-housing starts continuing at such a low ebb that over 75 per-

cent of all homes purchased by first-time buyers are now *existing* houses, projects like the one we've shown here offer just the type of inspiration people need to transform those less-than-ideal cookie-cutter houses into homes worthy of pride and devotion. ■

First test report on the revolutionary plastic tire

The long-awaited liquid-injection-molded polyurethane tire may go into production in two years

By **STUART MARSHALL**

ILLUSTRATIONS BY GENE THOMPSON

When PS learned that the well-known British automotive writer, Stuart Marshall, had become the first journalist to test a new generation of plastic tires, we commissioned him to do this exclusive report. Marshall has written extensively about tires. Independent confirmation and further details of the developments are not available as this issue goes to press. But because of the timeliness and significance of this news, PS editors decided to present it to our readers immediately. We will report on further developments as early as we can.

KITTSEE, AUSTRIA

The roads of Burgenland, Austria, were deserted when I set out in a BMW 315 followed by a test driver in an identical car. On long sweeping bends, we pushed the cars to 90 mph. Then we swung onto dirt roads, taking corners flat out in second gear. Every 20 minutes I swapped cars and repeated the same maneuvers. The cars seemed to react identically under these conditions. That would have been no surprise—except that one car rolled on conventional Continental TS 771 steel-belted radial tires, and the other on a new set of liquid-injection-molded polyurethane tires. Plastic.

There was no way I could tell which car had the LIM tires and which had the conventional radials until I swung into a severe bend. Then the cornering forces that made the radials whimper

Tread pattern of Polyair's latest-generation polyurethane tire—of the type that the author tested on a BMW 315—looks and feels exactly like a conventional rubber-based tire. The tread pattern is hand cut because Polyair has not come up with a final tread design at this time. Author Marshall thought tread on this tire resembled the pattern of a Michelin TRX super-performance radial.

produced a squeal from the LIMs. Pushed to the breakaway point, they let go a little earlier, but I found them marginally smoother riding and demanding less steering effort at low speeds than the radials.

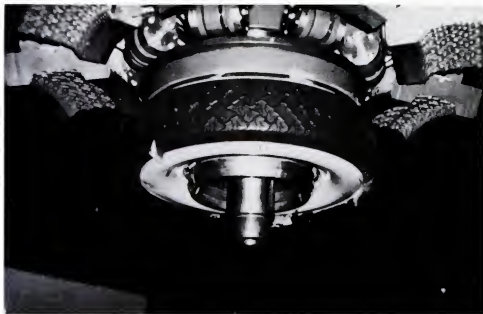
Tire companies have long dreamed of perfecting a liquid-injection-molded polyurethane tire. It would allow a simple automated manufacturing process to replace the energy- and labor-intensive process needed to produce today's radial and bias-ply tires. But more than 20 years have gone by since Goodyear first tried and failed to make one that could be marketed. Since then, Firestone and other companies have also tried to perfect the process, only to abandon the effort because of poor durability and performance

characteristics. Now, at last, a relatively small Austrian company that's not even in the tire business may have succeeded.

To get the story, I journeyed to the headquarters of Polyair Maschinenbau GmbH in Kittsee. There I met with the four Schmidt brothers who run the small company, which produces plastic-shoe-manufacturing machinery. Oscar Schmidt, president of the firm, told me how he got into the tire business.

"I was in Kiev in the Soviet Union in June 1973, exhibiting a shoe-manufacturing plant at a trade fair," Schmidt said. "It was late at night; a Russian trade official asked me if we could use our machinery and polyurethane expertise to make a viable car tire by the





LIM tire has just been molded and is ready to be taken off molding machine. Draw-

ings at right reveal how tire is molded in two-stage process for casing and tread.

liquid-injection-molding process.

"The vodka had been flowing freely, but I thought it was possible. So we entered into a research agreement."

Two years later, Polyair unveiled its first LIM tires. Journalists tried them and much publicity resulted, mainly because the tires were brightly colored and were thick-walled enough to run after being punctured by pistol shots. Some sets were made available to established tire makers, which tried them but were unimpressed. The research chief of a large German tire maker told me after evaluating LIM tires that they were no match for modern radials. "I would rate the LIM's performance as equal to that of a pre-World War II bias-ply passenger-car tire," he said.

Schmidt, however, confident that he had invented a better mousetrap, waited for the world—or the tire industry—to beat a path to his door. "We were not tire people—we just knew a great deal about polyurethane. But it soon became clear to us that the industry was more interested in obstruction than cooperation, so we started learning more about tires for ourselves."

Polyair stopped supplying tires for evaluation. "As a result, we are still being judged on the performance of our earliest experimental tires," Schmidt told me.

Polyair evolved more than 100 different formulations of polyurethane and tested them. By 1980, by Oscar Schmidt's reckoning, LIM technology had caught up with that of the steel-belted passenger-car radial. He now believes the LIM is a better all-round package. Does this claim stand up?

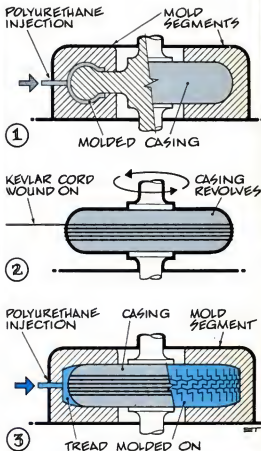
I came here to Kittsee to answer that question—by testing the latest LIM tires and seeing how they were made. To my surprise they were black, not colored. "We like to keep a low profile nowadays," Schmidt said. The tread pattern, hand-cut on a slick base because details have not been agreed on, was not unlike that of a Michelin TRX. The sidewalls had a dull sheen, and they did not feel like rubber. The tread yielded to a thumbnail like a normal, rubber-based tire.

My comparison tests in the BMWs were on dry roads, so there was no way to determine wet-traction capability. I asked Oscar Schmidt for proof that this important aspect had been brought nearer to the level of a present-day radial tire's. He showed me results of road tests conducted by Polyair chief test engineer John Morgan. His report compared two early types of the LIM tire and a then-up-to-the-minute one. Bridgestone steel radials were used as control tires. Rating the Bridgestones at 100 for wet traction, the test gave the two early LIMs 62 and 64 points, the latest one 104 points.

"That was nearly two years ago. We have made further advances since then," said Oscar Schmidt. He told me that a series of wet-traction and handling tests had been carried out more recently by a major European tire manufacturer at its computerized proving grounds. It yielded excellent results.

The manufacturer recently sent its director of operations to Kittsee, and a close association between his firm and

Continued



The polyurethane-tire manufacturing method is revealed in these drawings. Plastic is injected into the mold (1) for tire casing. When this stage is finished, the casing is revealed as mold segments are separated. Then the casing is revolved and wound with Kevlar fiber (2). In last step (3), more plastic is injected into multi-segment mold to form tread over the Kevlar.



This huge 40.00-57 earthmover tire is examined by the author. The tire was made by the LIM process in Polyair's plant in Kittsee, Austria.

Polyair is developing. (On the day this story was sent by Concorde from London to New York, I learned that a major European car manufacturer is launching a full evaluation of LIM tires on its proving grounds to learn whether they are suitable for its high-performance and cross-country vehicles, as well as for family cars.)

Testing of a different, elaborately documented kind was conducted by the government of Venezuela in October 1981. Two identical Fiat 131 sedans—one with LIM tires and the other with conventional radials—were driven 10,000 kilometers (6,215 miles) each on every kind of road. The conclusions:

- The car with LIM tires used 9.95 percent less gasoline.
- Tread abrasion was 51 percent lower for LIM, equivalent to 47 percent additional tread mileage.
- The LIM tires were 22 percent lighter than the other car's domestic Firestone steel-belted radials.
- Heat buildup was 54 percent lower in the LIM.
- Handling and general road behavior were classified as equal in the LIM to those of the radial tires.

The resistance of the LIM to high speed was demonstrated to me on Polyair's own test wheel. Two tires, one a bright-red LIM and the other a well-known make of steel radial, were inflated to 2.1 bar, or 30 lbs. psi, loaded equally to 792 lbs., and run up to 130 mph. (That's 17 mph above the official maximum speed rating of the SR radial.) After one minute, strobe lights showed that the radial had developed a large standing wave. Four minutes later signs of degradation appeared in the shoulder, and within a minute it had thrown its whole tread.

As soon as the wheel had stopped I went into the test house. The disintegrated radial had reached 140 degrees C (284 F) at the shoulder. The LIM, which had been used for similar tests before, was barely warm to the touch.

"There's no magic about it," said Oscar Schmidt. "Urethane has very little hysteresis. That's why it creates minimal rolling resistance, doesn't heat up, and can withstand high speeds without problems."

Polyair makes two kinds of LIM tires, one for on-off-road vehicles, including the largest mining trucks and agricultural tractors, the other for passenger cars. The large sizes, which have been made up to 40.00-57 for use in the Soviet Union, use the same polyurethane mix for walls and tread. The passenger-car LIMs have a different mix for the two parts. But the production process, except for one detail, is identical.

A multi-segment mold is closed and a shot of polyurethane injected under high pressure. After a brief time, which varies with the size of tire, the mold opens and another multi-segment mold closes around the casing. A further shot of polyurethane is then injected. When this mold is opened, the tire is ready for removal. After a post-cure period, it is ready for fitting to the wheel.

The one difference: With passenger-car sizes, when the first mold is opened an arm extends and a few turns of Kevlar fiber are wound around the casing as it spins. This is to prevent the tire from "growing" due to centrifugal force over thousands of miles. The big off-road tires do not undergo cord winding because they spin so much slower. All LIM tires have a conventional cabled-wire bead pre-positioned in the first mold before the liquid polyurethane is injected. Mounting techniques are exactly the same as for rubber-based tires, and the LIM may be used tubed or tubeless.

Recycling is no problem, Polyair

"If LIM takes off, it could do to the tire industry what TV did to the motion-picture business or what jumbo jets did to ocean liners"

claims. The wire beads are cut out of a worn-out LIM, and the whole thing may be recycled into raw material for other urethane products.

After an investment of some \$45 million in the LIM project over the past seven years, Schmidt envisions production in volume within the next two years. He believes that it is an ideal product for a country with a lot of oil, no established tire industry, and a growing number of vehicles. Saudi Arabia, for example. Middle Eastern money has been invested in a new holding company, LIM International SA, based in Luxembourg. There are unconfirmed reports that this company is negotiating to set up plants in Venezuela, Greece, and Saudi Arabia in the next two years. I have also learned that British Leyland is evaluating a group of LIM tires for possible use on some of its models, ranging from high-performance cars to four-wheel-drive off-road vehicles. Also, Polyair GmbH is planning to set up a small production plant at its Kittsee facility, where a pilot plant already exists—it's where all LIM tires have so

far been made. How many? Oscar Schmidt is unspecific. "About 5,000 to 10,000," he said.

How much will an LIM tire cost, compared with its conventional equivalent? Schmidt hedged. "Polyurethane is much costlier than the kind of synthetic rubbers used in tire making," he said. "But that's only a fraction of the story."

"I don't believe the product can be successfully marketed on a cost basis. It will sell because of its superior performance. But there will, at the same time, be substantial overall savings."

Why? The start-up costs of an LIM plant are minute compared with those of building a rubber-tire factory.

An LIM passenger-tire plant could, Schmidt said, be profitable with an output of only 500 units per day. Only two men are required to work a machine, even one with 18 tire-making stations, because the manufacturing process is computer controlled.

One of the major benefits of the Polyair process, Schmidt says, is that it de-scales tire making. An LIM tire plant could be set up in any light-industry area or even behind a large tire dealer's premises, much as the dealer now runs a recapping shop. He also sees LIM tire-making machines being installed in automobile-assembly plants.

How about reluctance on the part of the public to buying a plastic tire? Schmidt bristled. "It is *not* a plastic tire any more than the modern rubber tire, which, like LIM, is made almost entirely of oil-based materials."

And will the conventional tire-making industry go over to liquid-injection molding? Schmidt believes that it will have to eventually, for passenger-car, light-truck, agricultural, and earth-mover tires, anyway.

At present, none of the rubber companies is making real money out of tire manufacture because of ever-increasing energy, raw-material, and labor costs. And excess tire-making capacity makes it difficult to get sufficient price for their products. "Eventually," says Schmidt, "the shareholders will push the tire makers into using LIM technology, but there will be an agonizing shake-out of the industry first."

Schmidt's bleak prediction: If LIM really does take off, it could do to the established tire industry what TV did to the motion-picture business or what jumbo jets did to ocean liners.

My experience at Kittsee left me with a totally different opinion of LIM from what I had formed by talking to tire-industry spokesmen over the last few years. On the basis of my testing, I would gladly have a set of LIM tires on my own car.

Touch-screen communicator

puts the world at your fingertips



A London bank has the edge: a landmark system for instant communications

By DAVID SCOTT

LONDON

"We trade over \$1 billion even on a quiet day," John Brooks told me, "and transactions can go as high as \$3 billion. This touch-screen system speeds operation tremendously."

Brooks is the treasurer of Williams & Glyn's Bank, in the heart of London's financial district. We were in the dealers' room and in front of us were rows of video consoles. A shirt-sleeved operator sat before each terminal, occasionally poking the screen with the tip of his finger.

"Take a look at the supervisor's screen," said Brooks as he guided me over to a central desk. The screen was filled with 64 small rectangles, each with labels such as CHASE MANHATTAN and SHELL. He touched the box marked SHELL, and in a moment it started flashing.

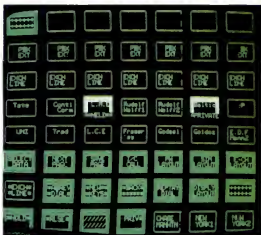
"That means a broker there has answered my call," Brooks said. "I can pick up the phone and talk with him."

Instant communications. It's become essential in the international money market, which is the bank's biggest concern. It's involved in foreign-exchange trading, and exchange rates for such deals can fluctuate hourly according to the strengths of different currencies.

The demand has made conventional phones and switchboards archaic. Here, they've been replaced by a City Business System (CBS) computer—the first of its kind in the world. The computer instantly links console operators to outside phone lines at literally—a touch. Each console video screen is crisscrossed with infrared beams of light to detect the presence and location of a pointed finger. The computer then uses this information to determine which of the 64 boxes has been selected.

Brooks touched a box marked PAGE SELECTOR and a new display appeared on the screen. "That's an index to other pages in our computer," he added.

Video screen contains a matrix of 64 boxes. Each is labeled for direct contact with banks, company treasurers, and telephone exchanges. A key-pad screen display can also be used for dialing numbers unknown to the computer.



"We have about 50 on tap." Each page contains specific information about certain groups: foreign-exchange brokers, Eurodollar traders, domestic clearing banks, and Williams & Glyn's own 350 branches throughout Britain. Any page can be selected by any of the 24 dealers on the bank's CBS circuit. Then by merely pointing to a box, the dealer can make hot-line contact.

Every page also contains several EXCHANGE LINE boxes. Touching one forms a telephone key pad on the screen for touch-dialing phone numbers not held in the computer's memory. Often-used numbers can be "dialed" by short codes of just two or three digits. The codes—and the actual numbers they represent—are programmed into the computer.

Incoming calls are handled just as easily. A flashing box, indicating a call, is merely touched by any operator on the circuit. The call is then automatically routed to his headset.

The displays can also handle computer data. The pages can be split horizontally: the top half showing text and data, such as exchange control regulations; the bottom showing boxes. Using a plug-in keyboard, a dealer can create or alter a display to meet particular needs.

"The system has great advantages over the setups at other offices we contact," said Brooks. "They usually use push-button switchboards that are limited by sheer size to 150 lines."

CBS has the capacity to hold 2,000 64-box pages—far more than presently required. Linkups with telex networks, viewdata facilities, and word processors are also possible. The CBS system was designed by British Telecom, 2-12 Gresham St., London EC2V 7AG, England.

Build extra living space

within your present walls

Part III



PHOTOS BY GREG SHARKO



Wall of shelves (top) holds a sizable book collection with ease. A pair of clip-on

spotlights on headboard illuminates artwork (above), gives reading light, too.

A storage headboard and a wall of shelves add bonus space in the master bedroom. Last in a series

By **RICHARD STEPLER**
DESIGNS BY THE AUTHOR

The principal extra space we created in this home-remodeling project is the master bedroom. It occupies the new second story we added above the dressing room and closets, and is reached via its own staircase (visible at right in the photo above). It's a generous room, measuring $12\frac{1}{2}$ by 18 feet at its longest point (see floor plan in Parts 1 and 2, PS, Feb. and March). In keeping with the theme of this series—extra living space—the built-ins contribute to the efficient use of space in the master bedroom:

- The peninsula position of the carpeted platform bed eats less floor space.

Water-base finishes

New ones even fight fire, rust, and condensation



These new formulas do jobs that you once trusted only to oil paints

By A. J. HAND

Water-base finishes: Everybody wants them. You and I want them for their easy application, fast cleanup, and lack of fumes. The EPA wants them because they don't fill the air with polluting hydrocarbons. The paint industry wants them in order to reduce its dependence on petroleum.

With all that motivation, it's no wonder that improvements in water-base finishes keep flowing our way. This year the improvements come from all across the spectrum of finishing products. We have new, clear urethane acrylics for indoors and out, plus a low-fume acrylic for floors. There are super-penetrating stains, and a new high-gloss acrylic enamel. We even have paints that fight fire, rust, and condensation in our homes.

Clear acrylics

The first water-base clear finish I ever tested was PPG's Rez Water-Based Varnish [PS, Sept. '75]. That was an alkyd-base formula for interior use only. Although that pioneering product impressed me in a lot of ways, it seemed to remain soft and sticky for days, even weeks, in humid weather.

Now Fuller O'Brien has a water-base, interior-exterior clear finish (Pen-Chrome Super V) based on a urethane acrylic formula, and Pierce & Stevens has a clear acrylic finish (Aqua Fabulon) tough enough for use on floors [PS, April '82].

Both of these new finishes seem to have overcome the problem of soft-

ness. After letting test samples of each finish set for a day, I sawed them in half and clamped them face to face. When I removed the clamps, the samples fell apart with no tendency to cling together.

Unlike oil-base varnishes, these clear finishes have no underlying yellow cast and will neither darken nor "warm" the woods you apply them to. This makes them very good for natural blond finishes on light woods such as white oak or ash. But I find them a bit cool and lifeless over dark woods such as walnut and mahogany.

Although Aqua Fabulon is promoted as a floor finish, and the label warns against applying it with anything but a pad, I experienced no problems brushing it onto small work. I see no reason why it couldn't be used on furniture and woodwork as well as floors.

Even so, its real advantage—weak fumes—is more important when you finish floors. I have used Fabulon's lacquer-base floor finish several times in the past. When you have a couple hundred square feet of the finish giving off fumes, it can do strange things to your head, even if you ventilate the room. This new acrylic formula is not odorless by any means, but it won't leave you lightheaded or give you a hangover, either.

Both of these finishes go on with a slightly milky cast if you apply them heavily, but when you brush them out they become almost invisible. For this reason, good lighting is a must. Without it you will probably skip spots. Whenever possible, place a broad source of light opposite you across your work. This will create reflections that make it easy to see where you have—or haven't—applied the finish.

Since these products are water based, they do tend to raise grain when applied to bare wood. A light sanding after the first coat will remove any whiskers. After that first

sanding, however, there should be no need to sand again. As with any clear finish, at least three coats are required for good depth and a smooth finish.

Aqua Fabulon dries to a medium high gloss, while Pen-Chrome Super V is available in flat, satin, and gloss finishes.

Water-soluble stains

One of the keys to a good stain is good penetration. Until recently, oil stains had the edge in this department. The reason? Oils have shorter molecules than the commonly used latex resins, and these shorter molecules can more easily penetrate wood's cellulose fibers.

It doesn't have to be that way. As Dr. Ramesh Vasishth, vice-president for research at Flecto, explains it: "Water makes wood swell and increases the size of the openings in the cellulose fiber, making it easier to penetrate. Petroleum solvents actually dehydrate the wood cell and shrink it. That makes penetration harder."

Two new stains take advantage of this fact, and they do so in remarkably different ways.

First, there is Maxum 1, from Premier Coatings. According to Premier's vice-president, Paul Petraitis, "This stain is based on a new acrylic resin with a particle size under a tenth of a micron. It's so small that it penetrates right into the cells of the wood."

Result? According to Premier, the finish breathes right along with the wood, and adhesion is increased. Maxum 1 is guaranteed never to crack, peel, or blister.

Cuprinol's new "red can" Stain & Wood Preservative achieves good penetration in an entirely different way. Actually, this isn't a latex stain at all. It's a whole new idea, based on linseed oil. But in this case, the linseed oil is waterborne, not dissolved in a petroleum solvent.

When in a liquid state, the oil is water soluble. Once it sets, however, water can't dissolve it again. Cuprinol's chemists developed this system largely for its easy water cleanups. Much to their surprise, the chemists discovered that the waterborne oil actually out-penetrates solvent-borne oil, and they have scanning-electron photos to prove it. Apparently, the wood-penetrating power of the linseed oil is increased by the fiber-swelling nature of water.

If you're committed to painting your house rather than staining, you'll be interested in Pittsburgh Paints' (PPG Industries, Inc.) new Exterior Latex Flat House Paint. PPG chemists created this new paint to solve the house painter's biggest headaches: cracking and peeling. They did it in two ways.

First, they minimized the use of inflexible mildewcide agents, ingredients that can make a paint film brittle and prone to cracking. Second, they discovered that a significant cause of paint failure is tension or stress within the paint film itself. A high-stress film has a tendency to curl, pull loose, and even take underlying layers of paint with it. Once the chemists discovered this, they formulated the new paint to eliminate stress in the film. Just *how* they did this, PPG won't say.

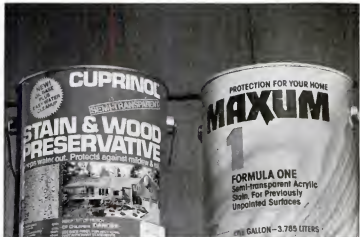
Now let's move indoors and take a look at a new interior water-base stain made with urethane and acrylic resins: Fuller O'Brien's Pen-Chrome Super S. After trying it out on a variety of woods, I found a lot to like. First, it isn't heavily pigmented, so it colors without hiding the grain of the wood. Most of the commonly available stains I have used are so muddy that they kill the natural fire that gives wood its charm.

A second advantage to this stain: The urethane and acrylic resins bind

Continued



One-coat enamel for metals combines primer and finish coat. It goes on over rust, too, if you clean off loose scale first.



Water-base stains actually penetrate better than oil stains; the water causes wood fibers to swell and open up more.



Blowtorching plywood paneling caused this contrast. Left half, protected by fire-

retardant paint, is covered by thick layer of blisters; right half is burned through.

the wood fibers together and act as a sealer. In many cases this lets you get by with one less coat of varnish. A third advantage: The stain dries fast and can be recoated in about two hours.

Like any water-base product, this stain will raise the grain of the wood slightly. You can avoid this by sponging the wood with warm water, letting it dry, and then sanding it lightly. Or you can forget about it, and sand away any slight roughness after your first coat of varnish has dried. Do not sand directly after staining, or you may cut through the stain in spots.

Paints and enamels

The high gloss and good wear of oil-base paint without the odor or inconvenience: That's what Fuller O'Brien claims you get from its new Versaflex Acrylic Enamel. In my tests, its surface sheen was good but not quite up to the standards of the alkyds and urethanes I keep around my shop.

Even so, the new paint is much more convenient to use. It flows on nicely and levels out well, producing a

hard film without any stickiness. If you're after the super-glossy wet look, oil-base paints are probably still a better bet. But if you don't need a mirror finish, this is a hard paint to beat.

Those of you with rusty metal in need of paint may want to consider Nybco's new No-Prime Rust Enamel. It's an acrylic paint formulated to go on right over rust, without wire-brushing or priming. You just remove loose, flaky rust, wipe off grease, oil, and dirt, then brush the finish on. I put some on my rusty mailbox, and a month later it still looks good.

Vapor-barrier paints

Any time you retrofit your home with insulation, you're asking for problems with condensation. The reason: Blow-in insulation, such as loose mineral wool or cellulose fiber, does not include a vapor barrier. During the winter, moisture from inside your home can penetrate the walls and condense. There it can reduce the effectiveness of the new insulation, cause wood to decay, and create adhesion problems with the paint on the outside of your house.

The solution is a paint-on vapor barrier, applied to the finish surface of your walls. A few years ago this would have involved using a smelly, slow-drying, glossy oil-base paint, then sanding it to remove the gloss for good adhesion, and then applying a coat or two of flat wall paint.

However, in 1979 the job got easier with the introduction of Glidden's Insul-Aid [PS, Nov. '79], a latex vapor-barrier primer. That finish eliminated the smell, slow drying, and sanding associated with the old oil-base technique. I liked it enough to

use it on the walls of my workshop. But Insul-Aid is still just a primer, and I had to apply flat wall paint over it to finish the job.

Now there's a vapor-barrier paint that also serves as a finish coat on walls and ceilings. Called Thermo-Paint, it's from Enterprise Companies (1191 Wheeling Rd., Wheeling, Ill. 60090).

Like Insul-Aid, it has a permeability rating of 0.6, well below the 1.0 permeability rating called for by DOE, HUD, and FHA. And like Insul-Aid it has been shown in tests to reduce heat loss (caused by damp insulation) as much as 20 to 21 percent. But unlike Insul-Aid, it comes in a variety of colors so it doesn't require top-coating. That saves you time and money.

Vapor-barrier paints such as Insul-Aid and Thermo-Paint have certain advantages in new construction as well as retrofits. They are cheaper and easier to use than polyethylene barriers, and since they do not cover the faces of wall studs as poly films do, they let you use adhesives to install your dry wall.

On the other hand, paint-on vapor barriers are not as effective at blocking infiltration. (That's why poly films are used extensively in all of today's super-insulated houses.)

Fire-retardant paints

These paints are not really new. They have been widely used in commercial buildings for years. But with the surge in wood stoves—and greater inherent risk of fire—fire-retardant paints deserve consideration in homes.

They come in two general types: Intumescent, and non-intumescent. Non-intumescent work by releasing a vapor, such as water or carbon dioxide, which tends to smother a fire. Intumescent usually do this, too, but also have an insulating effect that makes them even more retardant. They contain a high percentage of film-forming solids, including a catalyst similar to the ammonium phosphates used in dry-powder fire extinguishers.

When heated—usually past 350 degrees F—an intumescent paint will begin to foam up to more than 200 times its original thickness, forming an insulating shell. The effectiveness of this shell is astounding.

The photo shows a piece of prefinished plywood paneling, its left half treated with Albert-"DS," a clear fire-retardant coating. Both halves of the paneling were subjected to the flame from a MAPP gas torch at point-blank range for 90 seconds.

The untreated half on the right was

What new paints are made of

Alkyds are formed by heating an alcohol such as glycerin with an acid. The resulting resin is then combined with a drying oil. Commonly used oils are linseed, soy, and tung. **Urethane** is a plastic created when isocyanate reacts with alcohol. Combining this plastic with drying oils creates polyurethane, which cures without needing a two-part catalyst-resin system. **Acrylics** consist of a plastic resin—methyl methacrylate—familiar to us as Plexiglas or Lucite. It's emulsified to mix with water.

completely burned through, while the coating on the left half blistered but protected so well that when I later scraped away the coating, the original finish on the paneling beneath had not even discolored.

Fire-retardant paints are tested for their fire-retardant abilities in the "tunnel test." The specimen is drawn through a 25-foot-long tunnel and exposed to a violent flame and forced air. It is then rated for "flame spread," "smoke developed," and "fuel contributed" on a scale of zero to 100. Zero is the rating for asbestos board, and 100 is for untreated oak—so the lower the rating the better.

Building codes and the NFPA (National Fire Protection Assn.) give a Class A rating for tunnel-test scores of 25 or less. When you buy fire-retardant coatings, it makes sense to go for the lowest number possible. Some coatings—Albert-DS, for example—are rated at five for flame spread, and zero for both fuel contributed and smoke developed.

Most fire-retardant coatings are water based and white in color, although many can be tinted. Clear coatings are also available to protect natural wood finishes, paneling, and so on.

Some coatings are quite tough and can hold up to repeated washings and a humid environment. Others are not waterproof and must be coated over if used in wet conditions or where they will be exposed to wear and handling (doors, handrails, woodwork). But to maintain maximum fire protection, be sure to follow directions to the letter when applying or coating over fire-retardant finishes.

Who makes fire-retardants?

Most of the major paint makers include fire-retardant coatings in their product lines. In addition, there are a few manufacturers who specialize in these paints. Among them are American Vamag Co., 1060 Linden Ave., Ridgefield, N.J. 07657 (Albert-DS), and Flamort Chemical Co., 746 Natoma St., San Francisco, Calif. 94103. Any good paint store stocks fire-retardant coatings or can order them for you.

Fire-retardant coatings are not cheap. I paid \$40 for a gallon of Albert-DS. PPG's fire-retardant paint is about \$30; Benjamin Moore's, \$27; and Pratt and Lambert's, about \$36. What's more, these coatings must be applied quite heavily—about 150 to 200 square feet per gallon—so you can easily spend over \$100 painting a 12-by-12-foot room. Still that's a small price to pay if the paint saves your home . . . or your family. **[E]**

Infrared gas grill —speedier cooking, tastier results

One snowy afternoon last winter, I got together with Larry Gunn, Thermal Engineering Corp.'s (TEC) division manager for consumer and commercial products, for an unseasonable research project—a cookout.

Gunn had called me a few days before to tell me about his company's new gas barbecue grill, the Patio I infrared grill. "It really is completely different from anything on the market," he told me. "You have to see it work to believe it."

Hence the cookout in the snow.

While conventional gas grills I've tried [PS, July '79] vary by quality, design, and features, the engineering is basically the same: A gas burner with several hundred small ports burns below a rack of volcanic rocks or ceramic material. The burner heats the rocks, drippings from the meat above fall on them and vaporize. The smoke flows back over the meat and gives it that unique "outdoor" flavor.

But the new TEC grill has no rocks. Instead, the burner itself is ceramic—a special honeycomb material that forms more than 30,000 tiny ports. The heat it produces is intense (from 1,600 degrees F on high to 1,000 on low), much of it infrared energy. The radiant heat combines with convection to cook the food.

A conventional gas grill typically reaches about 1,200 degrees directly above the burner. But the tops of the volcanic rocks don't get nearly that hot. Convection, not radiation, does most of the cooking.

The infrared grill is an outgrowth of a special burner developed by TEC for a fast-food chain. More than 500,000 pounds of meat are broiled on it every day.

Naturally, I was anxious to cook a few pounds myself. So despite the snowstorm, I took a match and fired up the grill. Within a few seconds I felt the intense heat. Soon the burner glowed reddish orange.

Instead of the usual 10- to 15-minute warm-up time, Patio I takes



about three. By the time I walked inside and brought back the meat, the grill was ready. Meat prices being what they are, I warmed up with hot dogs and hamburgers before attempting to cook steaks. I found that with this grill I could sear meat quicker, sealing in the juices better than with any grill I've ever used. Total cooking time was much briefer—about one-third to one-fourth the time. And the results were excellent. The hot dogs and hamburgers were delicious; the steak, maybe the best I've tasted.

The TEC grill has the look and heft of commercial equipment. All stampings are heavy-gauge aluminized steel, carbon steel, or stainless. (You can even pop the stainless-steel grids into a self-cleaning oven for cleanup.)

Patio I will be available nationally by the time you read this. Or you can order from the manufacturer at Columbia Industrial Park, Box 868, Columbia, S.C. 29202. Accessories include a deep-fat fryer, griddle, wood-chip smoker, rotisserie, and a vinyl cover (which I recommend since the hood tends to retain water). At \$550, TEC's grill is more expensive than most, but with minimum care it should last a lifetime.—Evan Powell

After the winter's layover, it's time to **put spring in your mower**

By E. F. LINDSLEY

All the spring mower-tuneup instructions you've ever read probably say the same old things:

- Change the oil.
- Put in fresh gasoline.
- Install a new spark plug.
- Clean the air filter.

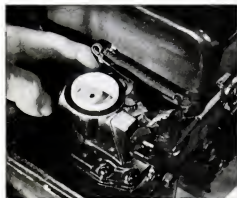
After that, if you trust what you read, you just sharpen the blade, oil the wheels, and away you go—maybe.

What if the engine refuses to cooperate? There's nothing more frustrating than spending hours trying to start a balky mower. To avoid such a hassle, here's a quick series of steps that'll get your mower going again, or at least prove that a trip to the local repair shop is really necessary. **1**

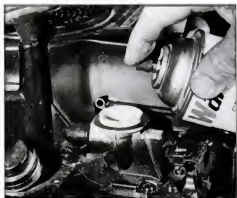


1. Whether your mower is a two- or four-cycle model, it has to have ignition, fuel, and compression to run. First check for ignition by removing spark plug, shielding it from bright light, and pulling starter rope with throttle in the "run" position.

Look for strong, hot spark. The clothespin shown is one way to hold a plug wire to avoid a high-voltage jolt. If you have no spark, consult your service manual for repair or take the mower into a shop. If you see a good spark, go to the next step.



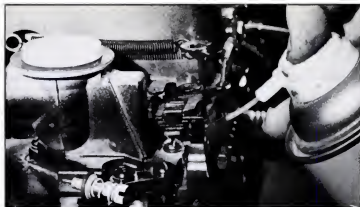
2. Remove the air cleaner and test the governor and throttle linkage for free movement. Open and close the throttle to make certain the spring pulls the throttle wide open in the "start" position. Check the connecting wire and choke action if manually linked. If the choke is automatic (as shown here), put your finger in the carburetor throat to test for free movement of the plate. A gummed-up choke plate may stick (and indicates that the carburetor should probably be cleaned).



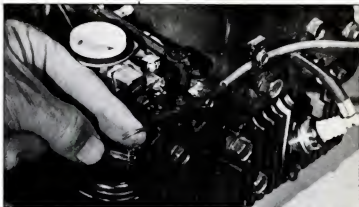
3. Spray a small amount of starting fluid into the carburetor throat and immediately pull the starter rope. The engine may now start. A burst of full-speed operation can clear a slightly gummed carburetor; if it does, you can start your work. But if the engine repeatedly starts and runs only a few seconds, the carburetor might be clogged, and it may have to be cleaned in a professional shop. But before you resort to that, check for other causes—proceed to the next step.



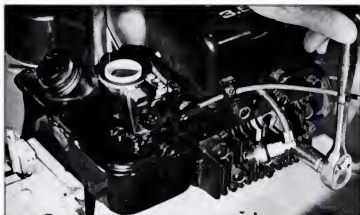
4. If the carburetor seems clogged, inspect the needle valve for gum (your carburetor may have more than one needle valve). Before removing a needle valve, first screw it down gently and count the number of turns (and fractions of turns) it takes to seat, so you'll know where to reset it later. Remove the valve and look it over closely. Brown or gummy deposits on the tip may be a sign that a complete carburetor cleaning is needed. Clean the valve, then go on to the next step.



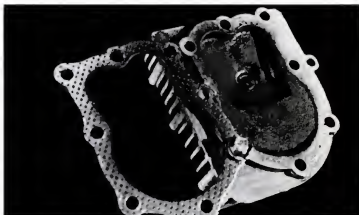
5. Squirt carburetor cleaner directly into the intake jet. Let the cleaner soak for a minute and follow with a flushing shot. Replace the needle valve(s) at the original setting(s), squirt a small amount of starting fluid into the carburetor throat again, and try to start the engine once more. Usually it will clear its throat, cough a bit, then run—and you can get on with mowing. But if the machine refuses to crank up now, you may have some other problems. Proceed to the next step.



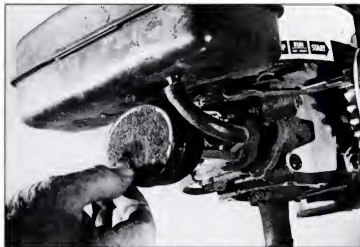
6. Erratic starting or stuttering while running may be a sign that this tiny magneto ground wire on the stop switch (part of throttle bracket) is grounding out. Dirt, grease, or moisture can do it. Slip the wire out of its clip and push it free of contact with all metal. (Disconnecting this wire deactivates all interlocks; if you start your engine with it out, you must short the plug with a screwdriver to stop.) If you get spark after freeing the wire, clean and check the sliding parts of the switch.



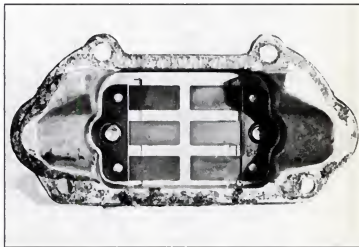
7. A leaking head gasket reduces compression, a common reason for hard starting. One method of checking is to apply gentle pressure against the head bolts. They should feel tight. If you find two or three that seem loose compared with others, especially in the exhaust-port area, it's almost certain your head gasket is leaking. It's not a good idea to rely on a compression gauge because you can get a false impression of what the true compression is—it may vary with each tug on the rope.



8. A typical bad gasket from a small mower engine shows dark areas (center, top) where gases were leaking. Matching area is visible on the head. Tightening the head down onto a gasket in this condition may get you going, but a new gasket, properly torqued, is the only real fix. If you have the tools and a reasonable amount of skill, you can replace the gasket yourself. In any case, do not overtighten any of the bolts; doing so will distort the head and cylinder.



9. A two-stroke engine must have compression in both its crankcase and its combustion chamber. The collection of oily dust on this air cleaner, plus other deposits around the carburetor, indicates that the crankshaft seals are leaking. Seals, which are vital to compression, are replaceable, but that's a shop job. Another problem in two-stroke engines is that the oil-and-gasoline mix tends to foul spark plugs easily. A plug that has its gap bridged with carbon cannot start an engine.



10. In a typical two-stroke engine, these six thin, flat reed valves admit fuel and air from the carburetor to the crankcase. Even fragments of grass holding one or two open will prevent the engine from starting. It always pays to check for fouled reed valves if you have the tools and experience to remove the carburetor for access. Valves shown are beginning to corrode. If there are other problems in the engine, such as bad bearings and seals (photo 8), it's probably not worth repairing.

Earth-bermed wood foundation

BY AL LEES
COLOR RENDERING BY RANDOLPH PADORR-BLACK

Architect Charles G. Woods has designed earth-sheltered homes in this series for the past three September Home-Improvement issues. Here he ventures into a springtime mode—and pays further homage to the architect whose work he most admires: Frank Lloyd Wright. (Woods apprenticed with former Taliesin student Dennis Blair—as did the artist of the Wright-influenced rendering below.) Woods dubs this new design his first “all-wood, earth-sheltered, passive-solar, super-insulated, double-wall house.” When I challenged him on that final claim, he explained: “It functions like one. There’s thermal-mass storage in that gravel below the wood floor; at night, a fan system moves the heat into the living space via that plenum floor.”

One of the most novel aspects of the house, though, is that its fully bermed walls are made of pressure-treated lumber and plywood, as in the “all-weather” wood foundations we’ve featured in past issues. This makes the house the easiest—and cheapest—for a novice to build of any Woods design we’ve offered so far. (The plans also detail a concrete wall, should you prefer to go a more conventional route.)

Because the roof is not earth-sheltered, 18 inches of insulation is packed between the plywood beams. The windless north and side walls can be notched into a gentle rise or erected on a flat plot with earth brought in for backfill berming. Waterproofing should be either a bentonite or butyl-sheet system [see “Underground Basics,” PS, Nov. ’82].

Note that there’s a planter along the edge of the roof. Seasonal vines help shade the windows from high summer sun but let in low winter rays, as shown in Section A-A. “With its built-in solar greenhouse,” says Woods, “this house has better heat gain and lower heat loss than any I’ve designed. In less severe climates, the heat-circulating fireplace may supply all the backup needed.”

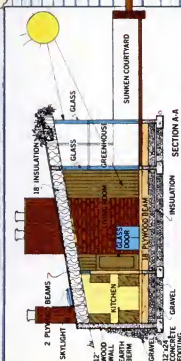
Access to the house is through either end of the greenhouse—which also functions as an air-lock entry. This double glass wall floods the living space with light from the courtyard or pool that lies before it. These areas are paved with flagstone or slate to both soak up the sun’s heat and reflect its light, bouncing it indoors; the greenhouse floor is part of the plenum system.

The plywood ceiling beams are four feet on center, which means the structure can be shortened or expanded in four-foot modules to suit your special needs. You could trim the garage to a single-car width or eliminate it altogether. At the opposite end, you could lop off the master suite and still have a complete two-bedroom house.

You may be reluctant to give up this end, though: The master bedroom, bermed on two walls, sports a private sunken court—as well as its own fireplace. Note that identical back-to-back bathrooms, a laundry room (with water heater), and kitchen are all in a line to minimize plumbing runs. These rooms along the rear berm are illuminated by overhead skylights.

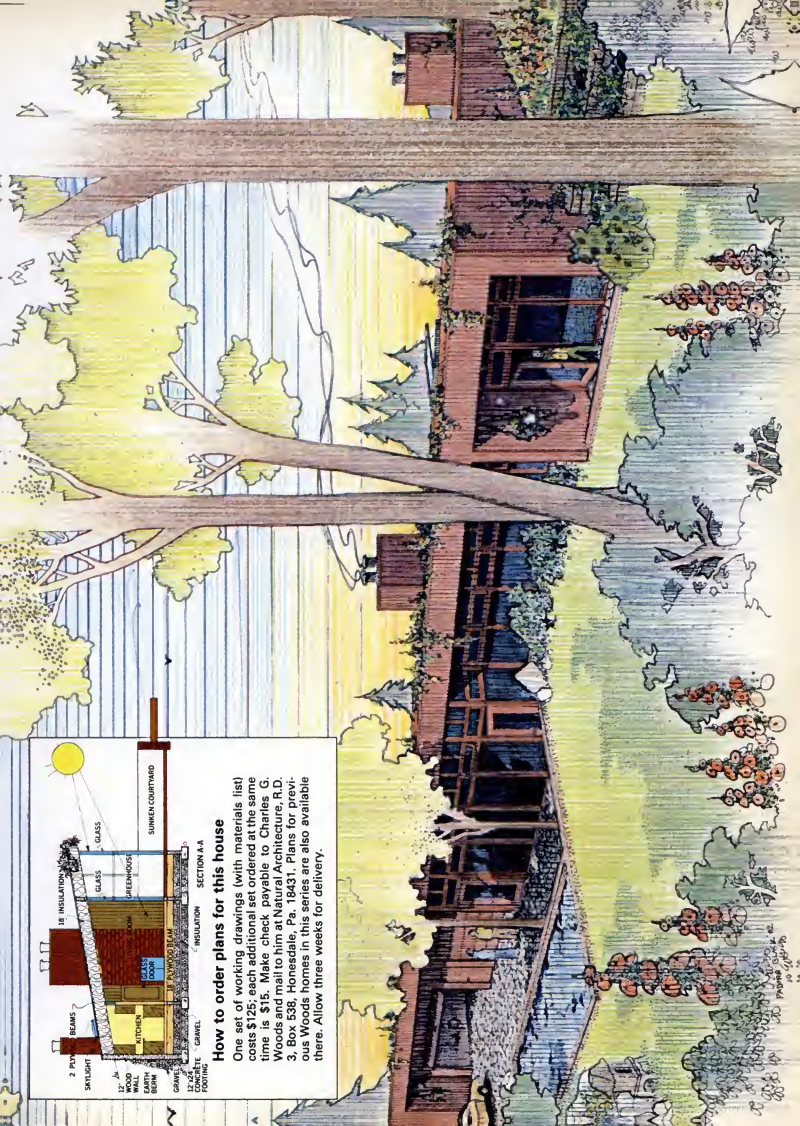
Earlier Woods designs in this series, as well as another 30 of his houses, are shown in his new book, *Natural Architecture*, \$15 from Webco Publishing, 110 S. Greeley St., Stillwater, Minn. 55082. Orders for the plans (see box for address) or the book should be in U.S. currency. **E**





How to order plans for this house

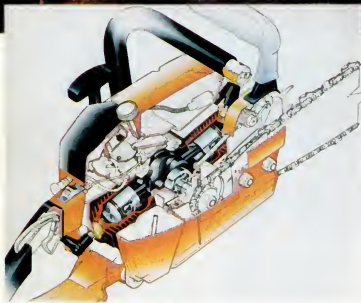
One set of working drawings (with materials list) costs \$125; each additional set ordered at the same time is \$15. Make check payable to Charles G. Woods and mail to him at Natural Architecture, R.D. 3, Box 538, Honesdale, Pa. 18431. Plans for previous Woods homes in this series are also available there. Allow three weeks for delivery.



ECHO

Two-cylinder chain saw

—smooth, quiet, and powerful



Cutaway of Echo's new chain saw shows lengthwise alignment of cylinders. Saw measures 16 by 10 by 11 in. (without bar).

Horizontally opposed cylinders make this saw almost vibration-free. That makes it tough on wood but easier on you

By E. F. LINDSLEY

I pulled the starter rope on Echo's new two-cylinder chain saw and instantly knew it was different. If no one had told me that this 61-cc (3.72 cu. in.) saw had two pistons simultaneously firing opposite each other, I would have been amazed, if not mystified, by its smoothness. Equally remarkable was its weight—it weighed about the same as an equivalent one-lung saw: 15 pounds.

The saw I tried, Model CST-600EVL, had a 20-inch bar and a $\frac{3}{8}$ -inch-pitch chain; obviously it was meant for man-sized sawing jobs. I tested it on an average-size wild plum tree and some scraggly limbs and brush. The Echo's slim lines and slick obedience to the throttle made it as handy a trimming saw as a felling saw.

The saw's automatic oiling lets you keep your mind on your cutting, even though there's a manual oiler button for a booster shot when you need it. The old, dried tree that I cut down was hard and tough, but the Echo sank through it as if it were a loaf of bread.

To understand this new saw you have to look inside: The two pistons on two crank throws run in cylinders placed lengthwise to the saw. Each piston reaches top dead center at the same time, and each combustion charge fires at the same instant—thanks to the electronic-ignition system. As a result, vibration is reduced to about one-tenth that of a single-cylinder saw, and heavy counterweighting can be trimmed to save weight. In addition, some unusual sound barriers are built into the cylinders and combine with a muffling system that takes advantage of the dual-exhaust impulses for dampening. Result: Exhaust noises are markedly reduced.

I was afraid that the two cylinders would complicate matters. No one needs a complex dual-carburetion system when he's out cutting wood. Happily, the CST-600EVL has a single carburetor that can be easily serviced. And the single electronic-ignition system means that you don't have to worry about synchronizing the two cylinders.

A deluxe version of the saw has an electronic readout that shows rpm, engine hours, fuel level, battery condition, and chain-oil level.

Echo (Box 578, Northbrook, Ill. 60062) expects the CST-600EVL to be used both commercially and by homeowners. The price: \$550.

EB

Computer analyzer

taps your car's brain

Starting here:
PS SPECIAL SECTION

Car Care News

By E. F. LINDSLEY

PHOTOGRAPHS BY GREG SHARKO



"Let's take your car out on the road and get some readings," says your friend. You agree, and duck into the right-hand seat as he drapes the umbilical cords to your new OTC diagnostic monitor over the sun visor. There, you'll

Continued

YOU DON'T RUN MILLION-DOLLAR EXPERIMENTS WITH A CHEAPLY MADE OIL FILTER.



Motorcraft EXCEEDS THE NEED

What existing oil filter could be selected for automobiles of such valuable technological stature?

Incredibly, many million-dollar experiments are guarded by a Motorcraft FL-1A filter — right off the shelf. Engineered to outperform all leading filters, the FL-1A's unique six-slot base accommodates oil flow rushes to nine gallons per minute. And an exclusive filter design incorporating a pleated filter element is blended with tough



man-made fiber. A superior material not found in cheaply made oil filters. The result?

Motorcraft FL-1A lasts longer and traps more abrasives than any other leading filter. So which would appear the better choice to protect your car? The Motorcraft filter proven in million-dollar experiments? Or one proven to trap less dirt for a shorter period of time? Motorcraft. Quality parts for all makes of cars. Get it together — buckle up.





3C ALCL Scanner does the same job as the OTC Monitor II. Made by Micro Processor Systems, Inc. (7641 19 Mile Rd., Sterling Heights, Mich. 48078), it features a rotary switch instead of a keyboard.

both be able to read the displays and tap in question codes.

Under the dash, one cord is plugged into the multi-prong connector that GM uses for the final checkout of the computerized engine controls. The other cord goes into the car's lighter for power.

Now, a few minutes later, you're driving down the road. You've already watched the monitor go through its own automatic internal test, and you've entered the proper identification code for your car. The display reads MODE?00. You touch the number "1" lightly and then press "Enter." Instantly the monitor displays 14. Your friend glances from the monitor to the GM booklet included in OTC's Monitor II kit. (The booklet and the GM factory repair manuals list the diagnostic codes.)

"Looks like you've got a coolant-sensor problem," he says. The trouble code 14 indicates that a problem with the coolant sensor has been locked into the car computer's memory. You go back to the monitor, this time tapping in "Mode 14." The engine-coolant temperature, as read by the sensor, pops into the display: 35° C [95 F]. "Something's wrong here," you mutter. "The engine should be warmed up by now." (A warm engine at road load should be reading about 95 degrees C [203 F].) "Let's take the car back," you say. "It looks like we're going to have to change the coolant sensor."

This scene may sound like a trouble-shooting session of the future, but

it's already being played by a few car owners.

Automotive on-board computers are found on most new cars today. In the future we'll see even more of them. Why? Manufacturers are using them to provide better drivability, performance, and fuel economy. In the past, complicated, time-consuming diagnostic procedures for the on-board computers have frustrated home mechanics and pros alike. Now, however, Owatonna Tool Co. (Owatonna, Minn. 55060) has developed a computer analyzer for late-model GM cars that makes trouble-shooting your car's black box as easy as pushing buttons.

OTC's Monitor II is about the size and weight of a good pocket calculator. Although not cheap at \$399, it isn't too costly for two or three GM-car owners to purchase and share. I visited OTC to find out if this electronic trouble-shooter really held hope for home garage mechanics who are baffled by on-board computers. Jim Wanberg, OTC's product specialist for electronics, quickly cleared up my questions on what the analyzer can and cannot do.

"Underneath all of these computer gadgets, there's an engine," Wanberg told me. "There are still vacuum leaks, warped intake manifolds, and blown head gaskets. Of course, our monitor won't pick those up. That's because it's a computer-control-systems analyzer, not an engine analyzer."

Wanberg pointed out that electronics superimposes a whole new set of trouble-shooting requirements on the basic engine. In fact, the new electronics often interact mysteriously with the old mechanical systems.

"A lot of people are blaming the computer for problems that are in the engine," Wanberg said. "Or you can have the reverse—blame the engine for what the computer's doing." He added, "Unfortunately, these computer systems tend to compensate, to cover up problems. A guy's car could be deteriorating and he wouldn't know it."

All of this means that if you're going to trouble-shoot today's cars, you need some way of sorting out engine troubles from computer troubles. I asked Wanberg if he could explain how the OTC monitor got the information needed to make this decision. "On all GM cars since 1981," he began, "there's a multi-prong plug called an ALCL [Assembly Line Communications Link], which they use to check out computer performance at the end of the assembly line." As Wanberg said this, he

flipped open a plastic cover under the steering column of his car. The plug he revealed was a mate for the monitor's plug. Carefully, Wanberg seated the monitor's plug in the ALCL connection.

"Now we'll give it some power," he said as he plugged the second wire from the monitor into the dash lighter socket. The Monitor II immediately ran through its own calibration check and signaled that it was ready for the car's identification code. Referring to the GM booklet, Wanberg tapped in his Buick's code. Satisfied that the monitor was healthy and functioning, he said, "Let's see what's in the memory."

By touching the "Mode 1" buttons, Wanberg asked the car's computer to scan its memory for troubles that might have occurred in the past or were occurring now. If the coolant sensor had been shorted, as in the opening scene, the number 14 would have appeared. If there was a problem with the throttle-position sensor, for example, code 21 would have been displayed on the screen.

Without the monitor, a computer checkout requires clipping a jumble of wires between the test terminal in the ALCL box and ground, then counting flashes of the "Check Engine" light. (The sequence of flashes for each code is repeated three times.) According to Wanberg, "Counting the flashes isn't so bad if you've only got one code, but if you've got, say, a 17, a 23, and a 55 and you have to sit there for three 17s, three 23s, and three 55s, it gets tedious and confusing." It struck me that trying to count code flashes on the road could be quite demanding and even dangerous.

GM's instruction manual says: "The system does not require special testers. A dwell meter, tachometer, test light, ohmmeter, digital voltmeter with 10 ohms minimum input impedance, vacuum pump, vacuum gauge, and jumper wires are required." There might not be anything special about these instruments, but they probably cost more altogether than the monitor.

I'd like to be able to tell you that the monitor furnishes a straight and narrow path to your car's problems. In some cases, as with the defective water-temperature sensor, it may work out that way. Remember, however, that the monitor is only a tool, and you'll still need some know-how to spot tricky glitches. But if you have a couple of like-minded friends who own late-model GM cars, with the Monitor II you'll be able to tackle your cars' black boxes with greater confidence and ease. **ED**

INTRODUCING THE ALL NEW TRIM-SIZE

FORD BRONCO II



IT'S A BRAND NEW KICK!!



FORD



Trim new 4-wheeler seats four, has split fold-down rear seats for extra cargo. Easy to park, fun to drive. It's a brand-new kick — on the road and off.

Built Ford tough with husky frame, Twin-Traction Beam suspension. Optional auto-lock hubs when engaged can shift 2WD to 4WD while moving.

V-6 engine standard, a V-6 with power S-10 Blazer can't match. And Bronco II turns in less space than S-10. The perfect size for 4-wheeling!



Protect your car, truck, or van—install a **pocket paging auto alarm**

Break-in . . . the car remains silent—a thief has no idea he's been detected. But your pocket beeper alerts you to call police.

These silent alarms warn you of a break-in when you're miles from your car

By **GORDON MC COMB**

One out of every 60 cars is stolen each year, the FBI says. Good odds? Nope, *great odds* for 59 other people in my neighborhood. But for me, it's a statistic I'll never forget.

As I found out, locking the doors simply isn't enough—a good thief can open a car door faster than you can fumble for your keys. Add a siren? Fine, but if your neighborhood is like mine, no one—including the thief—pays attention to it. A quick snip of a wire and all is peaceful again as he drives off.

But the newest car alarms don't have to make noise, blink lights, or warn a would-be thief in any way. Instead, when he opens a door (or triggers any other sensors you've installed), these new systems send a silent radio signal to a pocket beeper you carry with you. When the beeper

sounds, you call the cops. And if all goes well, the unsuspecting crook is literally caught in the act.

Adding a silent paging alarm to your car isn't difficult. But before you do, you need to know some facts about how they work, how they differ (models range in price from \$99 to \$259), and how they're installed for best protection.

How they work

All paging alarms are composed of two parts: a transmitter that mounts inside your car and a small, lightweight receiver you take with you.

The transmitter is wired to sensors and switches placed at strategic locations throughout your car to detect tampering or a break-in. When activated, the transmitter sends a dual-tone coded radio signal over the car-radio antenna to the remote receiver. The receiver, tuned to the same frequency as the transmitter, responds only to your special code—it beeps, warning you of possible trouble. Since there are more than 10,000 frequency-and-code combinations available with paging alarms, there's little

chance that a similar system in another car will interfere with yours.

The transmitters operate between the channels normally used by CBers and come in a variety of wattages. The Radio Shack Mobile Alert, for instance, has a ½-watt output and is claimed to have an effective range of ½ mile. The Anes Pro Alert 400 has a four-watt output. Its manufacturer claims a range in excess of eight miles, depending on terrain, weather, and type of antenna used with the transmitter.

Actually, a mileage figure is incidental—most people are rarely more than five or six blocks away from their cars. The extra wattage is important, however, for greater penetration through buildings and over rough terrain. For example, the signal from a ½-watt unit may not reach the receiver if your car is parked in an underground garage and you're 25 stories above it. But a four-watt transmitter might do the trick.

About half the paging-alarm systems come with piezoelectric sensors that "hear" a thief. Jimmy a lock,

Continued

Pocket paging auto alarm

(Continued)

smash a window, or even try towing the car away, and these small shock sensors detect it. (As shown in the photos, they normally mount on the inside of each door post. A sensitivity control allows you to vary the triggering level.) With most systems, you can attach up to six such sensors to the transmitter for full protection.

All paging alarms can also be activated by a simple switch closure. Pin switches can be mounted on all door posts, as well as on the hood and trunk. Opening the door closes the switch contacts, activating the alarm. Motion detectors—sealed bar-shaped switches that detect towing, collision, and theft—can be used with a paging alarm, too. In fact, you can connect any switch-activated device to a paging alarm.

Locating the transmitter

First step in installing a paging alarm is to pick a spot inside your car for the transmitter. It must be out of sight but within reach so you can easily turn it on and off. Ideal locations are under the dashboard, along the fire wall, under the seat, or in the glove compartment.

Try to place the transmitter as close to the car radio as possible—it con-

nects between the radio and the antenna. Don't choose a spot near a heating or cooling vent, though: Temperature extremes can damage the electronics.

Connecting is easy: Disconnect the antenna cable from the radio (it simply pulls out) and reconnect it to the jack marked "antenna" on the transmitter. Another cable (supplied) is then installed between the radio and a second jack marked "radio" on the transmitter.

If any of the cables simply won't reach, extension cables are available at local electronics or auto-supply stores. They come in two- to six-foot lengths and cost less than \$5. For my installation, the existing cables were long enough—although I had to re-route the antenna cable to get the extra three inches I needed to mount the transmitter properly.

A bracket or mounting template comes with the alarm to mark the position for the mounting screws. Use caution when drilling the screw holes: Make sure you don't drill into wiring, fuel lines, or other vitals.

Never connect the power leads to the alarm unless the antenna is connected. Running the pager with no antenna could damage its output cir-

cuitry. And the repair cost for that blunder could be as much as the price of a new unit.

Sensor and switch installation

The effectiveness of any auto alarm—audible or silent—relies on how well the points of entry are protected. For maximum security, all doors, the hood, and the trunk should be protected by a switch or sensor from break-ins.

Piezoelectric sensors are glued to any flat, clean surface—ideally the door posts, if there's enough clearance between post and door to prevent crushing the sensor. Use epoxy or an instant glue to cement the sensor. Stay away from such thick or rubbery adhesives as sealant or double-sided tape—these will cushion the sensor from the car, making it insensitive to noise.

How you run the sensor wire to the transmitter will depend upon your car. I drilled a small hole in the post and threaded it through a rubber grommet (to prevent damage to the wire), then led the wire down inside the post, under the door threshold, and to the transmitter. If you don't want to get this fancy, you can tape the wire alongside the post and run it



Apply thin layer of glue to mount the piezoelectric sensor. Be sure mounting surface is dry and clean. For good bond, tape sensor in place until glue sets.



Sensor cable goes through a rubber grommet (for protection) into the door post. Remove the inside rear-wall panel and work cable under rug to transmitter.



Bullet connector for pin-type switch is crimped on its single connecting wire and inserted into the switch. Use this type of switch on metal surfaces only.



Pin-type switch may be mounted in two ways: In blind spots, screw it directly into the mounting hole. In other areas, use a rear nut for additional strength.



All wires connect to the rear of the transmitter. Be sure no wire strands short across any terminals and all connections are secure, to avoid false alarms.



Final mounting of transmitter depends on car. Here, mounting bracket was bolted under the dashboard, in front of air-conditioning ducts and out of sight.

underneath the carpet or floor mat. You do the same for all doors you want protected.

You may find that the sensor wire isn't long enough to reach the transmitter. If so, buy 22-gauge shielded wire and splice it on. (Don't use speaker wire or lamp cord—it's not shielded and will cause false alarms from stray electrical noises.) A neater—but more expensive—solution: Buy a sensor with a longer wire from the alarm manufacturer; prices range from \$14 to \$18.

You can mount pin switches only in metal surfaces since they use a single wire and the vehicle's metal chassis to complete the circuit. To mount the switch, drill the proper size hole and either screw the switch directly into the metal or use a nut to secure the switch in place (see photos).

At the switch, crimp one end of the wire into the bullet connector. At the alarm, connect the wire into the "trigger," "in," or "switch" terminal (the name will vary depending on alarm model). If you're installing a motion detector or other switch-activated device, it connects to the "trigger" terminal, too.

If you already have an alarm in your car, use its switches and detectors to also trigger the paging unit. Simply run a single wire from the trigger input of the audio alarm (which is where the existing switches are attached) to the trigger input of the transmitter. Your audible alarm will operate in the normal way but will send a silent signal, as well.

Finally, connect the power to the transmitter. Nearly all paging alarms use a 12-volt-DC, negative-ground system. (If your car's system is different, a special unit must be ordered from a manufacturer.)

Connect the black, or ground, wire of the transmitter to a metal point on the frame or fire wall. You can also connect the ground wire directly to the "-", or ground, terminal on the battery, but this is usually less convenient.

Then connect the red, or power, wire from the transmitter to an unswitched terminal on the vehicle's fuse block—one that doesn't lose its power when the ignition switch is off—or to the "+," or positive, terminal at the battery.

Testing and use

To test the alarm, put batteries in the receiver (usually AA alkalines), and turn it on. Next, turn on the transmitter. The system will trigger, and the receiver should begin beeping. To stop it and ready the system, close all protected entries on the car and press the "reset" button on the receiver.

Individually open each protected door—the pocket unit should sound. If it doesn't or if the alarm will not properly reset after triggering, check your wiring for possible shorts or breaks. Also, check the sensitivity control on the receiver.

If all goes well, test the range and effectiveness of the alarm by having a friend trigger the transmitter every minute or so while you walk away from the car. Can't get very far away without losing the signal? Check the antenna: The type and quality of your antenna will greatly affect the range and penetration capabilities.

A standard telescopic AM- or AM-FM-radio antenna that's in good shape should give you fair results. But an antenna integrated into the windshield, one that is broken or corroded, or one that retracts automati-

cally when the ignition or radio is turned off will greatly reduce the range of the alarm. If you have one of these, consider installing a separate antenna for the alarm system. A standard CB antenna is a perfect choice—either a permanent type or one of the newer magnetic types that can be removed when not needed.

Several models, such as the Page Alert 4000 and Crimestopper Security Products 4800, have the necessary CB-type connector on the transmitter to accept a separate antenna. On units without the proper connector, use a "UHF SO-239 to Motorola type" adapter, available at CB and electronics dealers.

If you already have a CB radio and you'd like to use its antenna for the alarm, you must install a commonly available two-way coaxial switch. The switch prevents the power produced by one transmitter from flowing into the other. It also maximizes the transmission efficiency for both the alarm and the CB radio. Simply switch to the alarm mode when you are leaving the car.

Many manufacturers offer extra transmitters and receivers that are coded alike. Order extra receivers for other drivers in your family, for example, or identical transmitters for other cars. All car alarms and all receivers will work together.

Call your insurance company—they may give you a special discount for an alarm-protected car. (Usually only specific alarm models qualify.)

Lastly, don't forget that there are many non-vehicle uses for pagers, too. Attach a 12-volt-DC power supply and a CB antenna to the transmitter, and you can protect just about anything—a shed, garage, or the gate to your swimming pool. **B**

PS buyer's guide to paging auto alarms

Manufacturer	Model	List price (\$)	Range (miles)	Accepts sensor	Output (watts)	Comments
Anes Electronics, 4112 Del Rey Ave., Venice CA 90291	Pro Alert 400	129.95	More than 8	Yes	4	Comes with pin switches and sensors
Chapman Industries, 2638 United Lane, Elk Grove Village IL 60007	Air Alert	199.95 to 259.95	1-2	Yes	4	Price includes installation; extra receivers and transmitters are available
Crimestopper Security Prod., 9620 Topanga Canyon Pl., Chatsworth CA 91311	4800	199.95	4	No	4	Silent-and-audible-alarm combination; extra receivers and transmitters are available
	4000	159.95	4	Yes	4	Extra receivers and transmitters are available
Micronics International, Box 6319, Anaheim CA 92806	TX-1000	99.95	1	No	1	Extra receivers and transmitters are available
	TX-4000	n.a.	n.a.	No	4	Extra receivers and transmitters are available
Page Alert Systems, 23842 Hawthorne Blvd., Torrance CA 90505	500A-1	99.95	1	Yes	1	Extra receivers and transmitters are available
	4000	129.95	2	Yes	4	Extra receivers and transmitters are available
	4444	159.95	2	Yes	4	Security and page operation; extra receivers and transmitters are available
Radio Shack (local store or dealer)	Mobile Alert	99.95	1/2	Yes	1/2	

Gas-charged shocks

New low-pressure types tame tight turns and sudden bumps

Constant volume changes make damping tricky. Gas pressure helps

By FRANK LEWIS

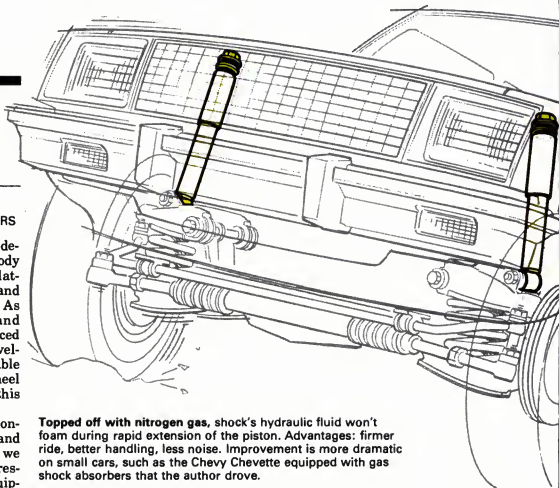
DRAWINGS BY RUSSELL VON SAUERS

The white Chevette made the 90-degree turn easily with almost no body roll. Before me was a mildly undulating gravel road with a high crown and drainage ditches on both sides. As stones flew from the tires and thunked on the wheel wells, I glanced at the speedometer. We were traveling at 45 mph, yet the car was stable without any of the unsettling wheel hop that the previous ride over this same route had produced.

Dennis Schall, an engineer at Monroe Auto Equipment, leaned over and explained: "After the first trip, we substituted a set of our new gas-pressurized shocks for the original-equipment versions. Where you pick up the difference right away is in handling and stability."

I had to agree. On the second run I unconsciously increased the speed by 10 mph, not from any desire to go faster but simply because the car felt better and I was more confident at the wheel. It was an impressive demonstration of a new type of shock absorber that uses nitrogen gas as well as hydraulic oil to control and damp the motions of a car's suspension. These low-pressure-gas shocks are a combination of conventional double-tube hydraulic shocks used on American cars and more exotic, expensive high-pressure-gas single-tube shocks used on European performance cars.

Several improvements are claimed for these new shock absorbers: better



Topped off with nitrogen gas, shock's hydraulic fluid won't foam during rapid extension of the piston. Advantages: firmer ride, better handling, less noise. Improvement is more dramatic on small cars, such as the Chevy Chevette equipped with gas shock absorbers that the author drove.

handling, reduced body roll, quieter ride, more consistent control on different road surfaces, less fading and loss of control during extended operation, and prices competitive with existing heavy-duty shock absorbers and replacement struts.

Original equipment

Low-pressure twin-tube shocks now come as original equipment on 1982 Lincoln Continental and 1983 LTD II and Thunderbird models. Also, the two major aftermarket shock manufacturers, Monroe and Gabriel, are offering replacement low-pressure-gas shocks and struts for most cars and light trucks. List prices range from \$20 to \$85 each.

Although I have no intention of

buying a new Lincoln, I would consider replacing the shocks in my two small cars if I were convinced that there really was an improvement in ride. That's how I came to be test-driving cars and pickup trucks on back-country roads and interstate highways. I also talked with engineers from the car companies and shock-absorber manufacturers. What I found out will help you decide if you want a set on your car.

The development of low-pressure-gas shocks and struts resulted from the shrinking of size by American car makers. The challenge: how to make small cars ride like the big ones they were replacing. The problem was most acute on luxury models because

Continued



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the unit-body construction of new cars doesn't absorb noise and jolts as does a separate frame.

One possible way to provide a ride that smooths out minor road irregularities is to use more-open valving in the shock absorber so that the hydraulic fluid flows more easily from the outer reserve tube into the working chamber (see box).

But when Ford tried this for its new, smaller Continental, engineers ran into a problem called hydraulic imbalance. Though more fluid was passing into the bottom of the shock absorber, an equal amount did not flow past the piston into the upper half of the shock. Mervyn Carse, supervisor of the shock-absorber section of Ford Engineering, explains:

"The problem occurs on the jounce stroke, when the spring and suspension move up into the body. Inside the shock absorber, the piston moves farther into the pressure tube. The piston rod takes up a certain volume, so you have to displace an amount of fluid equal to that. This rod volume in effect pushes fluid out the bottom of

Continued

How shocks work, and why double-tube gas shocks work better

Despite its name, the function of a shock absorber is not to cushion the car from the bumps of the road. The car's springs do that. What the shocks do is limit, or damp, the up-and-down motion of the springs, which would otherwise continuously oscillate like the box springs on a tired bed. Since the suspension system is what keeps a car's wheels on the road, effective damping is much more than a matter of comfort: It directly affects handling and ride control.

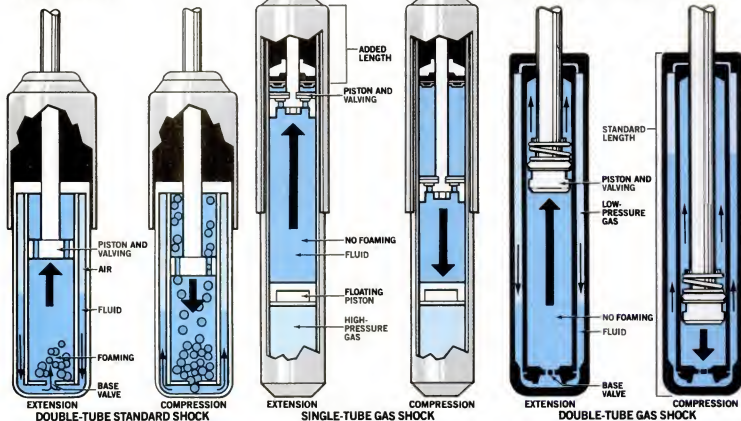
This damping is accomplished by linking the car's suspension system to a telescoping tube filled with hydraulic oil on both sides of a moving piston. As the wheels and springs move toward and away from the car body in response to the road (technically called jounce and rebound, respectively), the shock's piston moves back and forth in the tube, passing the hydraulic fluid from one side to the other through a series of valves and orifices. The pressure of the oil against the moving piston damps spring oscillation, converting motion energy into heat energy. The amount of damping provided depends on the velocity of the piston movement: The faster it moves, the more resistance there is.

There are three major shock-absorber designs. The conventional double-tube hydraulic shock absorber, in use since the 1930s, has an outer reserve tube of hydraulic fluid surrounding its inner working chamber. The reserve fluid is used to compensate for changes in volume that occur in the pressure tube as a result of piston-rod movement. The design weakness of a twin-tube hydraulic shock is that it cannot always transfer fluid between the two tubes quickly enough. During rapid extension, it's possible for the piston rod to exit the working chamber faster than fluid can be drawn from the reserve tube, creating a partial vacuum that vaporizes some of the fluid and draws dissolved air out of the fluid solution. Such cavitation and foaming seriously reduce damping on the compression stroke.

The single-tube gas-pressurized, or DeCarbon, shock was developed in Europe during the 1950s in response to the cavitation problem. Instead of the outer reserve tube of oil, a separate pressure chamber containing nitrogen gas at about

400 psi is added in-line beneath the working chamber. The two chambers are separated by a second, floating piston, which moves up and down to balance the pressure of the gas below and the oil above as the volume of the working chamber changes with piston-rod travel. This design eliminates the fluid-transfer problem, but DeCarbon shock absorbers have design weaknesses of their own. First, the high-pressure gas requires expensive sealing techniques and materials. Also, the added area beneath the floating piston makes the shock longer than the equivalent twin-tube version—too long, in fact, to fit today's smaller automobiles.

The new double-tube gas shock absorbers are a synthesis of the other two designs. They have an outer reserve tube like conventional shocks, but the hydraulic fluid there is topped off by pressurized gas. Thus when the shock extends, the fluid gets an extra push into the working chamber, preventing cavitation under most circumstances. This keeps the valves free of foam and provides more-consistent damping. But since the gas pressure does not exceed 200 psi, expensive manufacturing techniques and elaborate seals are not needed.—F. L.



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the shock through the base valve.

"However, at the same time, fluid is transferring from one side of the piston to the other. If the amounts are equal, the system is hydraulically balanced. But if more fluid is pushed through the base valve than you replenish at the top of the piston, you pull a vacuum across the piston and air comes out of solution. When the shock reverses its direction, the piston first travels through the layer of foam thus created, and you feel a sudden jolt or harshness."

By adding gas pressure to the shock, Ford designers discovered they could open the base valve up sufficiently to smooth the ride in the low-speed bump range without causing foaming on top of the piston. Ford decided to use gas shocks and struts on its cars and requested bids for these devices from its suppliers.

One of those suppliers, Monroe, was caught off guard at first. "Prior to the fall of 1980, we knew about two-tube gas shock absorbers, but nobody was marketing them, either here or abroad," says William Rankin, Monroe's vice-president of product engineering. The company made a quick decision to develop its own version. Two years later, the program resulted in original-equipment contracts on the '83 LTD and Thunderbird and the aftermarket line of shocks I tested in that white Chevette.

Monroe wasn't the only company to see the potential of a low-cost gas shock absorber. Gabriel took a different approach, however. Instead of producing gas shocks, it concentrated on MacPherson struts.

Struts come first

Unlike a shock absorber, a MacPherson strut is an integral part of the suspension—a structural component that combines spring and shock absorber in one compact unit. Struts are becoming more popular because they save space and reduce weight by eliminating the need for an upper control arm and ball joint.

Like Monroe, Gabriel realized that a low-cost gas unit was possible using the basic assembly method and components of its non-pressurized strut. The main difference is a better seal at the top of the strut, one able to seal gas as well as fluid. Gabriel claims the seal will last for years in actual use and, like Monroe, guarantees its gas shocks and struts for the car's life.

"We pick up a lot of the benefits of a gas shock in our strut," says Michael Kobiske, Gabriel's manager of shock-absorber engineering. "We charge the nitrogen gas to about 150 psi, a little bit less than in our gas shocks, but be-

*Result may vary according to car condition, filter change interval and where and how you drive.

cause the piston-rod diameter in a MacPherson unit is larger, it translates into a higher force. It also has a higher spring rate because the rod diameter is larger going into the working chamber, displacing more oil and therefore compressing the gas more over the piston travel range."

Gabriel says that this additional spring rate results in a firmer ride with better handling. The highly compressed gas will make it harder to bottom the suspension and will also extend the shock more quickly, keeping the wheels in better contact with the road surface.

In addition, tests by both Gabriel and Monroe show a decrease in noise levels inside the car. Gabriel claims a one-to-five-decibel reduction in sound level, depending on the car and road surface. (A three-decibel change is noticeable by the average person.)

It's one thing to document the improvements gas shocks provide in the lab, but the true test of a shock is the subjective ratings of drivers. How much difference will you notice? That depends on the condition of the shocks replaced, the types of driving surfaces encountered, and even how sensitive you are to body and suspension movement.

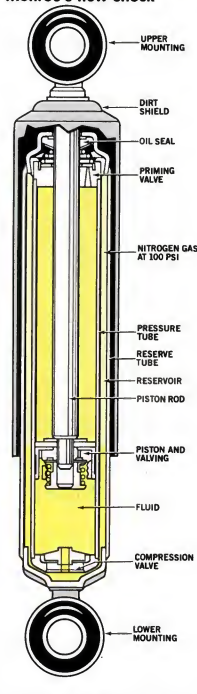
Traditionally, replacement shocks are valved stiffer than original-equipment versions. Car makers tune a suspension when everything is new and tight. By the time shocks are ready for replacement (shock companies say after two years or 20,000 miles on average) the rest of the suspension has loosened up, too.

The replacement gas shocks I tested were all stiffer. In cases where the original-equipment shocks on the test cars were not worn out, I could feel more improvement on small subcompact cars than on full-size models. The improvement shows most in situations such as crossing railroad tracks or traveling on patched road surfaces at moderate speeds of 20 to 45 mph.

In all cases, body roll was reduced, particularly when changing lanes at highway speeds. Noise was also reduced, but because of the complicated pattern of vibration and panel resonances each car produces, I wouldn't bet that all cars will be noticeably quieter.

If you decide to purchase a set of gas shocks or struts, you may find that supplies are limited in your area. Monroe started shipping its first gas shocks last summer and is due to ship its first MacPherson-strut cartridges sometime this spring. Gabriel's strut replacements were available as of last fall. The company started adding shock absorbers to the line this past

Monroe's new shock



Low-pressure gas shocks are a synthesis of conventional and high-pressure gas designs. Nitrogen gas fills the top of the outer hydraulic-fluid reservoir, keeping fluid in pressure balance above and below shock's piston. This prevents fluid from foaming.

winter. But just because the manufacturers have these products in the catalogs, don't assume your local parts store will have them for all applications.

While no dangerous driving conditions will result from mixing gas shocks on one axle with conventional shocks on the other, if it's gas shocks you want, be sure to get them. One way to identify a gas shock is to press it together and let go. If the shock extends by itself like Pinocchio's nose after a fib, then there's gas inside. **[E]**

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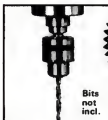
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Spot-weld gun for DIY auto-body work



Kel Arc uses four-prong tip for spot welds on flat surfaces. Corners and recessed areas (such as piece in background) are welded with two-prong tip.

Even if you've never welded in your life, you'll enjoy instant success with the new Kel Arc spot-welding gun. Most home welding jobs involve light-gauge sheet steel, which is easy to burn through or warp when using an arc welder. Spot welders confine the heat to a concentrated area, easing those problems.

The Kel Arc gun, made in England, is ideal for replacing auto-body panels, assembling metal structures that would otherwise require rivets, and repairing almost any steel that can be cleaned to a bright surface. It operates from any small transformer welder capable of providing 50 amps. Unlike most industrial spot welders, which apply the welding electrodes from both sides, the Kel Arc gun operates from one side and requires only firm hand pressure.

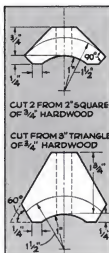
The technique is easy. You merely pull back the trigger to withdraw the carbon welding electrode. This lets you accurately locate the weld point without eye protection. With the gun held firmly against the metal, you relax the trigger and the spring-loaded carbon moves into contact. In a few seconds the metal glows and forms a small molten puddle. Then you gently pull back the trigger again, and a tiny arc develops. Secure welds are produced in four to five seconds.

The gun (you supply the welder) is available for \$28 from Keller International Marketing, 405 Hillsboro Parkway, Syracuse, New York 13214.—E. F. Lindsley

Easy-to-make, easy-to-use belt tightener



You can adjust belt tension by just turning wing nuts with this homemade tool. The nuts, on a threaded rod, spread apart two wooden wedges that push the pulleys apart (photo) until the belt is tight.



Here is a simple, inexpensive tool you can make that will solve those sometimes difficult—and always irritating—belt-tension-adjustment problems on your car, truck, and other belt-driven equipment. To adjust belt tension with the tool, you just install it between the pulleys involved and turn the tool's wing nuts until the tension is right. Then you tighten the mounting bolts to hold the tension.

With this tool you'll have both hands free to do the job.

To handle all your belt-tightening tasks, you'll want a variety of rod lengths. Buy a three-foot length of 7/16-inch threaded rod, measure the distances between all of the pulleys where you expect to use the tool, and cut the rod into lengths about 1/2 inch shorter than these measured distances.

Three shaped wooden pieces—one like the large wedge in the sketch at left and two like the small one—should handle all your belt-tightening tasks. To make them, take a piece of 3/4-inch hardwood and cut off one two-inch square and one equilateral triangle, three inches on a side. You make the two smaller pieces from the square and the larger one from the triangle. Shape them according to the sketch. The dimensions are not critical, but these pieces should have their front edges curved and tapered to fit into the flanges of your pulleys. After the pieces have been cut, you can form the curves and tapers with a drum sander (installed in a drill press or portable drill) or with a half-round file. Finally, drill a hole through the center of each piece for the rod.

To complete your do-it-yourself belt tightener, you need two 3/16-inch wing nuts and one hex nut. With this combination of ingredients, you'll have a very versatile tool. Where pulleys are close together, use the two small wood pieces, a short rod, one wing nut (for the adjusting), and the hex nut (to save space). Where space is adequate, use the large wood piece on one end of the rod (as shown in the photo). With it you'll have more takeup space for the adjustment than if you use the two small pieces. By choosing from your selection of wood pieces, rod lengths, and nuts, you can customize your belt tightener to every job.—

Melvin R. Thacher

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TAKING CARE OF YOUR CAR

By STEVE MERCALDO

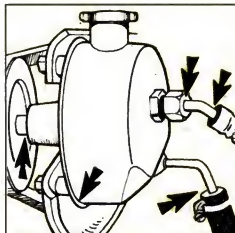
Got a useful car tip? Send it (with Social Security No.) to Car Care, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. We'll pay \$50 if we use it. If two or more readers send the same tip, payment goes to the one with earliest postmark. No tips can be returned.



RTV-silicone sealant for gaskets

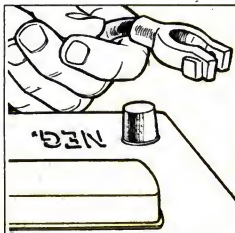
Room-temperature-vulcanizing (RTV) silicone sealant is such a good formed-in-place gasketing material that most valve-cover gaskets are replaced with it. However, there are some applications where RTV should not be used: where it may come in contact with diesel or gasoline fuels, where pans or covers have a stiffen-

ing rib, where the gasket acts as a shim or spacer, and where it will be sandwiched between two machined surfaces. Users should also be aware that RTV is temperature rated. Be sure both mating surfaces are clean. Then apply a continuous bead to one mating surface, encircling all bolt and stud holes. Allow RTV to cure.



Leaky steering pump

The actual source of a power-steering-pump leak should be determined before attempting an overhaul or replacement. Often, a leak can be cured by tightening a line fitting or replacing an inexpensive O-ring. Begin the inspection by wiping the pump's exterior clean. Next, add or remove oil. Start the engine, and turn the steering wheel full left and right several times. Inspect indicated areas for leaks.



Battery drain

Many late-model cars and trucks have electronic devices that require a small, continuous electrical charge even when the engine is not running. Although this condition is normal, the resulting current drain—as slight as it is—can discharge the battery if a vehicle is left unused. Disconnect the battery's negative terminal to cut this charge if your car or truck will be out of service for 30 days or more.

Continued

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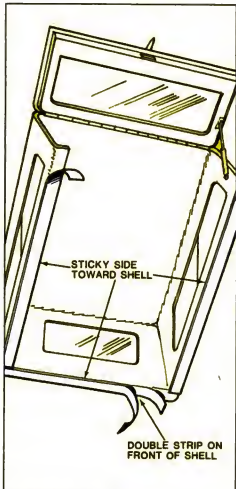
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Taking care of your car

(Continued)



Weatherstrip tip

Weatherstripping tape keeps water and wind out of your pickup's camper shell. To keep the bed neat after you remove the shell, install the tape with the sticky side toward the camper. The truck bed will stay clean, and because the tape becomes part of the shell, it can be used again. Use a double strip along the shell's front.

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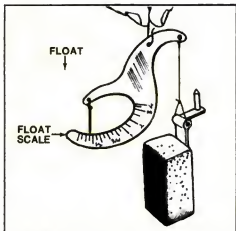
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Carb flooding

Replacing a needle valve and seat may not always cure a flooding problem. If your car's carburetor has a closed-cell-foam float, the float may become saturated with fuel. Even a partially saturated float weighs more and is less buoyant. Thus it will not shut off the needle valve—even though the float height may be properly adjusted. Use a float scale to determine if the float is causing flooding.



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Jig, band, or saber

—match the saw to the job

Remodeling? Inlaying?
Making furniture? One of
these curve cutters is best

By R. J. DE CRISTOFORO

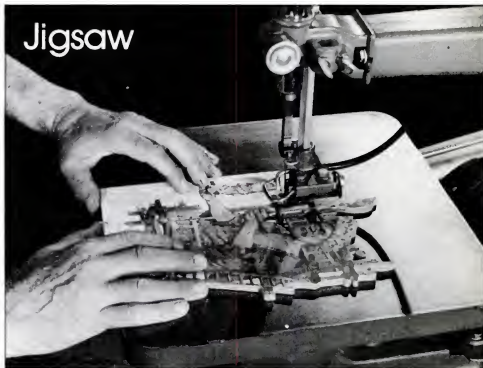
Do the jobs you do call for more than a coping saw? Often the hardest part of a project is choosing the right power tool for the job. This can be especially true for curve cutters: saber saws, jigsaws, and band saws. Whatever your project, however, there's a saw that's best for the job.

The saber saw

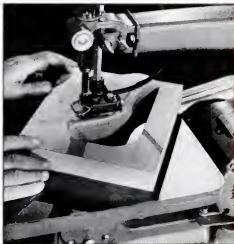
The chief advantages of the saber saw are its small size and portability. When introduced, saber saws were touted as portable jigsaws. Good saber saws can rival those stationary tools but can't totally substitute. For one thing, since a saber saw's blades are chucked at one end only, even the smallest blade must be strong enough to provide rigidity. That strength comes at the expense of maneuverability: The saber saw's blade is necessarily larger and can't be turned in a cut as easily as a thinner one. For the same reason, its kerf may be wider, too. With the right blade, though, a saber saw can cut through pipe, sheet metal, thick wood, or dense plastics.

The saber saw can do one thing the others can't: plunge cutting. You can make internal cutouts without a starting hole by resting the tool on the front end of its shoe and, with power on, arcing downward slowly and firmly so the blade does its own piercing. There are times when this is the only way to make a start, but I use a starting hole whenever possible, especially

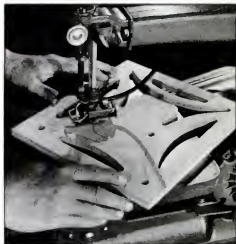
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Jigsaw is best for fretwork, silhouettes, and inlaid work. No other curve cutter can take blades so fine that they can almost turn on their own radii.



Depth of cut is respectable on jigsaws—you can stack blanks for identical pieces, cutting as you would a solid block.

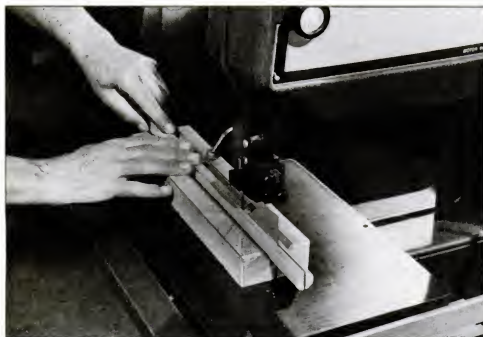


To pierce without sawing in from side of work: Drill starting hole, then insert blade through hole and chuck it.

Band saw



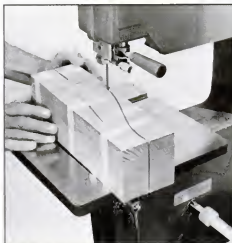
For resawing, choose a band saw. Though you could work freehand, it's best to use a high fence, which you fashion yourself. Feed slowly, and use a wide blade.



Quick way to halve or quarter round stock safely: Make a V-block jig with a sheet-metal guide in the kerf. The guide keeps the work from turning as you cut.



Deep cuts must be guided slowly. If you force the work, the blade can bow into the cut and make it slightly irregular.



For compound cutting: Mark adjacent sides of the stock, cut one side of the work, replace waste, then cut the second side.

when the hole can form a corner of the cutout. If you want to turn your saber saw into a stationary tool, you can buy (or make) a table that mounts the saw underneath—with the blade extending upward.

The jigsaw

Jigsaws use plain-end blades held in place by upper and lower chucks. A jigsaw can work with extremely fine blades; no other shop tool can make such smooth cuts, fine kerfs, or intricate turns.

The jigsaw is often thought of only for its craft applications, which is really not fair. It's a rugged machine that can work with fairly heavy blades and can do such practical jobs as sawing two-inch stock and pad-sawing six or eight layers of 1/4-inch plywood. And you can easily cut hard or soft metals, plastics, laminates, and other non-wood material such as ivory, bone, rubber, leather, and paper.

Try this trick: Tilt flat stock to about five degrees, then cut a series of concentric rings, always keeping the work on the same side of the blade. Each ring, when assembled, will jam into its neighbor, creating a bowl shape from a flat board.

One limitation of the jigsaw is that it can't cut stock wider than the opening of its arm. On some models, though, the arm can be swung down or removed entirely, which lets you use the tool as a stationary saber saw.

The band saw

No tool cuts as fast or has a greater depth of cut. Lumber mills use band saws (usually called band mills) to saw logs into boards. These monster machines can handle blades as wide as 12 inches. Band saws for home use usually have a six-inch depth of cut and can work with blades up to 1/2 inch wide, adequate for most chores.

Like the jigsaw, the band saw is often judged by one of the things it does well—compound cutting, a technique used to shape furniture components such as cabriole legs.

To make a compound cut, draw a pattern of the project's profile on adjacent sides of the stock. After cutting one side, put the pieces back into place with tape or nails driven in waste areas. Cut the other side. The waste falls away, leaving the shaped part.

Compound cutting is also a good way to prepare stock for lathe-turning since it's a fast means of removing material you would otherwise have to cut away with chisels.

You can do resawing (cutting thin boards from thick ones) easily with a band saw. And you can cut rounds

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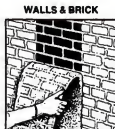
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Div. Brand Name Testing, Inc.

How curve-cutting saws rate

Operation	Saber saw	Jigsaw	Band saw
Pad sawing	Good	Better	Best
Piercing	Good	Best	-
Plunge cutting	Best	-	-
Reasawing	NR ¹	NR	Best
Halving rounds	NR	Good	Best
Crosscutting	Better	Good	Best
Ripping	Better	Good	Best
On-site work	Best	NR	NR
Fretwork	NR	Best	-
Large-panel work	Best	Good ²	NR
Compound cutting	NR	Good	Best
Circular cutting	Best	Good	Good
Sanding	-	Good ³	Good ³
Filing	NR	Best	-
Bevel sawing	Better	Good	Best
Internal beveling	NR	Best	NR
Inlay work	-	Best	NR
Metal cutting	Good	Good	Best ⁴
Preparing lathe stock	NR	Good	Best
Forming slots	Good	Good	-
Smooth cuts	Better	Best	Good
Cutting speed	Better	Good	Best
Depth of cut	Better	Good	Best
Width of cut	Best	Better ²	Good

¹NR: Not recommended

²If arm can be removed or swung down

³With accessories

⁴If equipped with speed control

from six-inch-thick stock—again, the tool's cutting speed and capacity make it ideal for such work.

As a curve cutter it rivals the saber saw, but because of its width-of-cut limitation (usually between 11 and 14 inches, the distance from the blade to the arm support) it isn't as flexible. Generally, band saws can handle blades $\frac{1}{4}$, $\frac{3}{8}$, and $\frac{1}{2}$ inch wide, though some will work with $\frac{1}{8}$ -inch-wide blades.

The band saw can be used for guided ripping or crosscutting as long as the blade is sharp and in prime condition. If the blade "leads"—that is, moves to the left or right (caused by incorrectly set teeth)—you should replace or recondition it.

My choice? If I were building a home or remodeling one, doing outside chores such as erecting fences and building decks, refacing a room with paneling, or putting in an extra window or skylight, I'd work with a saber saw.

If I were working in my shop mostly for fun—making puzzles, inlaid pictures, silhouettes, toys, and small projects or shaping cornices and valances—I'd use a jigsaw.

And if furniture construction, modern or traditional, were my main interest, I'd like to work primarily with a band saw. **[E]**

Saber saw



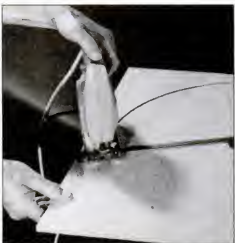
Saber saw can handle a six-in. blade, which is long enough for four-in. stock. (Most long blades have large teeth with a lot of set—don't expect smooth cuts.)



For intricate cuts: Saber saws that have scroller mechanisms allow you to turn the blade independently of the tool.



Make internal cutouts by cutting between starting holes drilled at corners. This avoids plunging the blade into stock.



Make perfect circles by using a circle-cutting saber-saw attachment such as the do-it-yourself version shown here.



With the correct blade, you can cut non-wood material such as dense plastic. Saw shown above is cutting Du Pont's Corian.

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PS4

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Easy-steering, versatile workhorse

As I eased the deck of the John Deere Model 420 tractor up to a tree, I swung the wheel around with fingertip pressure. The front end headed almost sideways. Toeing the left-wheel brake tightened the turn even more.

What's the secret of this 20-hp tractor's amazing agility? Part of it is a power-steering hydraulic cylinder that cramps the wheels tighter and more easily than any tractor I've ever driven. Speed comes from the high range of the two-speed hydrostatic drive. And for ground-engaging work and hard pulling you simply flip the range lever to low.

Combine those features with a 60-inch mower deck, three-point hitch, 2,000-rpm PTO (power takeoff), shaft drive to the mower, plus a three-function hydraulic system, and you have a versatile workhorse of a tractor. The 420 is sturdily built with a transmis-



Power steering on John Deere 420 turns wheels without sloping. For hard pulling,

sion-oil cooler and filter, full-pressure oiling to the Onan two-cylinder engine, and Stellite exhaust valves and seats with rotators. The hydro lever gives you an infinite speed range—from 10.5 mph down to the slowest creep.

Although Deere says the 420 is basically a grass cutter, it also takes a rear mower, a 48-inch tiller, 54-inch

if one wheel starts to spin, just step on the differential lock to get going.

front blade, and 49-inch single-stage or 47-inch two-stage snow blower. The three-function hydraulic controls let you lift the front blade and angle it right or left hydraulically. Price of the Model 420 with either bar or turf tires is \$6,359. The mower deck is an additional \$1,169. John Deere Horicon Works, Horicon, Wis. 53032.—E. F. Lindsley

The 1983 Plymouth Reliant K Backed for 5 years, 50,000 miles.



41 est. hwy. 29 EPA est. MPG*

Low-cost hydro-drive tractor

How do you mow a large lawn and move snow from a fair-size driveway without spending big money? Simplicity's 11-hp Model 4211H is one answer.

The tractor offers the best of both worlds—a lighter, lower-cost grass cutter plus a snow-throwing workhorse. Its 36-inch, staggered-twin-blade deck handles lawns up to one and a half acres easily. The blade's overlapping cutting pattern prevents streaking. In the winter, thanks to its hydrostatic drive, you can get down to creep speed for grinding up big drifts with a 36-inch snow thrower. Among other options: a 42-inch dozer blade.

If you don't live where it snows, you can get the same tractor with a five-speed transmission (Model 4211) or an eight-horsepower engine (Model 4208G).

Mindful that hydros stored in the cold are almost impossible to start because of the drag of the hydraulic flu-



Tractor's hydro-drive control is at front of seat. Brake pedal also disengages drive

for starting. Wheel weights, unneeded for cutting, give traction for snow thrower.

id, the 4211H designers added a foot clutch so the starter doesn't have to turn both the engine and the transmission.

Other features I liked: a tip-up hood and seat for full access to both engine and battery, a foot-operated combination brake-and-clutch with a clever toe-lock parking brake, an exception-

ally easy-to-pull deck lift, a fuel-level gauge, and an optional five-bushel grass catcher.

The Simplicity 4211H with 36-inch mower deck lists for \$2,350. The five-speed-gear Model 4211 goes for \$1,960. Simplicity Mfg. Co., Port Washington, Wis. 53074.—E. F. Lindsley

Reliant SE Interior not available on base model.



Plymouth is making Made in America stand for quality, durability and value.

America's lowest price 6-passenger front-wheel drive car: \$6,718**

The Plymouth Reliant K success story continues into 1983. It's solidly based on computer-designing, testing and assembly. Robot-welding means uniform long-lasting bodies. Front-wheel drive gives you and your family secure, safe, consistent going through snow and over wet spots.

Plymouth has added still more value to Reliant K: power brakes, halo-

gen headlamps and maintenance free battery. Standard. Ten horsepower has been added to a 2.2 litre engine.

5 years or 50,000 miles protection and 11.9% financing available

Every Reliant K is backed with 5 years or 50,000 miles protection on engine, powertrain and transmission and against outer body rust-through.

Chrysler gives 11.9% annual percentage rate financing†† on all new '82 and '83 cars. Your dealer has details.

Hundreds of thousands of Plymouth Reliant K owners know: This is the American way to get your money's worth.

Buy or lease from your Chrysler-Plymouth dealer.

Buckle up for safety.



The American way to get your money's worth
THE NEW CHRYSLER CORPORATION
Quality engineered to be the best.

*EPA est. MPG for comparison. Your mileage may vary depending on speed, trip length and weather. HWY. & CA. mileage lower. **Base sticker price excludes title, taxes and destination charges. ††Whichever comes first. Limited warranties. Deductible may be required. †††Through participating lenders & dealers for qualified buyers taking delivery by March 31.

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8 mg
tar.

Camel Lights.
Low tar. Camel taste.

18 mg. "tar", 0.7 mg. nicotine av. per cigarette. FTC Report DEC. '81.

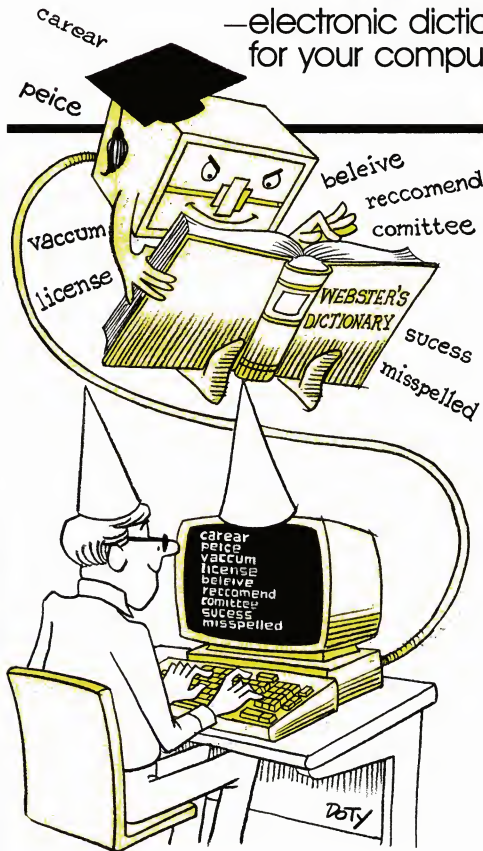
Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.



PUTTING
YOUR
COMPUTER
TO WORK

Spelling checkers

—electronic dictionaries
for your computer



End time-taking drudgery!
Here's the sort of work
computers were made for

By PHILLIP GOOD
ILLUSTRATION BY ROY DOTY

*"A man who is occupied with government or other important affairs cannot and need not attend to spelling."—
Napoleon Bonaparte*

Brave words when you're soon to become emperor of France. But for ordinary mortals who must put their thoughts into clear language for their bosses, co-workers, friends, and teachers, poor spelling can jeopardize a job, sale, and grades—as well as comprehension. Unless you're in line for an emperorship, a computerized spelling checker should benefit you.

Spelling checkers are computer programs stored, along with a digital dictionary, on a magnetic disc. The computer compares words in its memory, produced by a separate word-processing program (PS, Feb. '82), with those in the disc dictionary. When the checker program suspects a spelling error, it alerts you in various ways.

Checking for correct spelling is precisely the sort of repetitive, time-consuming drudgery that computers are designed to handle. My first spelling checker came on a disc as part of a word-processing program; it seemed to do a fine job. But after trying others out of curiosity, I quickly learned a lesson: There are big differences between spelling-checker programs, and the most expensive one is not necessarily the most effective for you.

Humans check a document for misspellings much differently from the

Continued

way a computer does it. When you or I proofread a document, we check a word at a time, referring to the dictionary as needed, and make corrections as we go. The computer, on the other hand, proofs a document in stages:

First, the spelling-checker program and the document to be checked are transferred from the discs to the computer's memory. The program then scans the document, looking at all the words in the document. If you spelled the same word wrong throughout your text, the spelling checker notes it only once. It will know the others must be changed, as well.

The program then compares those words—one at a time—with the words stored in its disc dictionary. If it finds a match, it assumes the word is correct. If it doesn't, the program displays the word on the screen and asks you to decide what to do.

Generally, you've got three choices: You can ignore the word—helpful for proper names or special words you seldom use. You can add the word to the dictionary—the word is spelled correctly but it's not in the dictionary. Or you can tell the program it has, indeed, found an error.

What happens next, however, depends on which spelling program you use.

Your time is what counts

I held a stopwatch on the computer when I first began testing for differences between various spelling-checker programs. But I soon realized I was timing the wrong animal. A computer's time is not important; mine is. The time I spend in front of the machine—pressing keys, changing discs, leafing through a dictionary, or merely waiting until I'm needed—is time wasted.

Some spelling checkers do just part of the job. They flag the errors in the text but leave it to you to make the corrections.

My first spelling checker was like that. It would replace the last letter of every misspelled word with a special symbol. Then I'd have to go back through the document with my word processor, find each incorrect word by searching for the symbol, get the correct spelling (using a traditional dictionary), and make the change.

Other spelling programs imitate the human method. They work in conjunction with a word-processing program, moving through the document a word at a time and displaying the errors as they're found within the text.

I found both methods inefficient. For short documents, such as letters, they're fine. For large documents,

such as manuscripts and books, I had problems using them.

The first technique often makes you use a dictionary twice (unless you have a short text or a long memory): the first time to query you whether an incorrect spelling has been found when the program displays words it doesn't recognize (not just a word that's not in the disc dictionary). But you can't make the correction then. On the second time you actually correct the misspellings as you go through the document looking for words you've marked with the special symbol. (You could write each word down on a piece of paper on the first go-round, of course, but this is just more wasted time and a lot of extra work on long documents with lots of questionable words.)

The second technique loses time because you must wait while the computer runs through the text, bouncing you between the spelling program and the word-processor program. Even with a disc, this time adds up when many words are involved.

I did find some programs that worked well for me, however. MicroProof, for example, has a 50,000-word dictionary and can scan a 10-page document in 80 seconds. As with the others, the program displays each unknown word in the text and allows you to ignore it, correct its spelling, or add the word to the dictionary. However, give MicroProof another command, and it will show the word in context—within the sentence where it's used. You can quickly see if *ther* should be *there* or *their*, for example, and you don't need your word processor to see it. (Nor do you have to see every word in context.) That all adds up to much greater efficiency. Also, after you've gone completely through the list of misspelled words, MicroProof will substitute the correct words in your text and add the new words to its dictionary—both automatically.

Another program that I like is Electric Webster. It, too, inserts your corrections and updates its dictionary automatically. But it has another clever trick: It suggests correct spellings for missed words. To do it, the program displays the closest match to your word from its dictionary. I found that it often pinpointed the word I was trying to spell, saving thumbing through the dictionary. If you're given to using words like *isochronous* or *gnomon*, however, you may be wasting your money on this feature.

Dictionary sizes

Some spelling-checker programs come with very small dictionaries: 10,000 words or fewer. Such checkers



Electric Webster program "signs on" (top photo) by asking for the name of the disc file that contains the text to be checked. It then gives you a readout (center) of its findings and lists missed words. Finally, it takes one word at a time and asks for your decision. If needed, you can see the word in context (bottom).

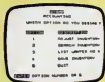
are usually quite inexpensive, but they miss many misspellings because the words aren't in their dictionary. That means, of course, that you'll quickly lose any saving in the time you spend checking and adding words.

Although some spelling checkers have large dictionaries—50,000 or more words—I found that a 25,000-word dictionary is more than adequate, providing you can add words to it. Usually, you don't have to add many words. In the past six months, for example, I've added only about 700 words to my checker's dictionary (mainly technical words on computers and computer-related topics).

Words are appended to the dictionary in two ways, depending on the program. Some programs merely add the words to the end of the original dictionary. That's fine, but the entries aren't in any logical order for the checking program to use them. In time, as the additional word list grows, the program will show signs of slowing down.

Continued

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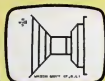
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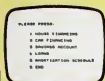
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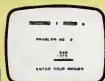
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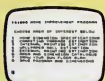
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*Sinclair technology is the heart of both the ZX81 and the Times/Sinclair 3000

Spelling checkers

(Continued)

The cure is simple, however: Push a special key on the keyboard, and the checking program performs a "file maintenance." In a few minutes, the dictionary is automatically reorganized with your new words in the proper sequence for searching.

Other programs employ separate dictionaries on the disc. MicroProof, for instance, uses two: the one that comes with the program and a second one that consists of words you have included.

The words may be added to the supplemental dictionary while you're proofing a document, or you may add (or delete) an entire list of words in a separate, independent process.

The real advantage, however, is that you can pop in a disc containing a special dictionary of engineering, legal, or medical terms, for example, depending on the work you're currently doing. A single, massive dictionary containing all these terms simply wouldn't fit on most discs.

What was that?

At times, a computer can seem awfully human—it makes mistakes. Of course, with a computer the mistakes are totally "logical." For instance, certain punctuation marks, such as a hyphen, dash, and apostrophe, present problems for some spelling checkers. A dash, for instance, could be taken as

part of a word. And an apostrophe could mean adding an 's to the end of every noun in the dictionary. Hyphens are a special problem: Sometimes they are needed, and sometimes they should be ignored. Before you buy a spelling program, check it out in the store with *bullet-proof* and *buzz-saw*. Spelling checkers that simply ignore the hyphen will accept them. But in standard usage, *bullet-proof* is one word and *buzz saw* is two; neither uses a hyphen. Normally, hyphenated words are displayed and you must judge them for accuracy.

Since many programs display all potential errors in lower case only, you could be surprised by fragments such as *ca*, *ct*, or *co*. That's a minor problem, however, since they are only the lower-case abbreviations of California, Connecticut, and Colorado.

You may also see letters such as these if your word processor uses special embedded commands or control characters for special purposes (to put a word in boldface, for example, or to start a new page). Naturally, though, you quickly become accustomed to seeing these displays and ignore them.

There is one other potentially more serious problem with many spelling programs: They can miss an incorrectly spelled word. It can happen because of something called "hashing."

Hashing means that a numerical representation of each word is stored in the dictionary—not the word itself. This coded form of the word is called a hash version, and it usually takes up less room on the disc than the word it represents. This makes the dictionary smaller (allowing more to be squeezed onto one disc), and it also makes the searching go much faster.

The problem occurs when there's a hash collision (their words, not mine). That means the word being checked in your document has the same code as an accepted code in the dictionary. MicroProof, for example, accepted *hyphenated* in my text. Mathematically, the incidence is rare; it can happen, though.

There is one final limitation to all spelling checkers: Don't expect them to correct your grammar. *To, too*, and *two* are all acceptable spellings, but you've got to know how to use them, too.

A spelling-checker program is not a replacement for proofing your document—or learning how to spell.

Quite the contrary, in fact. By repeatedly showing me words I had commonly misspelled in the past, it has taught me to spell them correctly. And that has helped my overall style of writing: I've become more confident with old words and more daring with new ones.

PS guide to spelling-checker programs

Manufacturer	Program	Comments	Manufacturer	Program	Comments
Apparat, Inc. 4401 S. Tamarac Pkwy. Denver CO 80237 (303) 741-1778	CheText	For TRS-80 III, 10,000-word dictionary	MicroComputer Ind. 500 E. Oak St. Fort Collins CO 80524 (303) 221-1955	Prospell Plus	To be used with WordPro on Commodore 8000 series, 30,000-word dictionary
Artal, Inc. 5547 Satsuma N. Hollywood CA 91601 (813) 985-2922	Magic Words	For Apple II, 14,000-word dictionary, doesn't correct errors in context, won't catch errors in hyphenation	Micro Pro Int'l. 33 San Pablo Ave. San Rafael CA 94903 (415) 499-1200	Spell Star	To be used with Wordstar on CP/M- or MSDOS-based computers, 20,000-word dictionary, won't catch errors in hyphenation
Aspen Software Box 339 Tijeras NM 87059 (505) 281-1634	Proofsader	For TRS-80 III, 38,000-word dictionary, doesn't correct errors in context	Oasis Systems 170 Laurel St. San Diego CA 92101 (714) 291-9489	The Word Plus	For CP/M-based computers, 45,000-word dictionary, suggests correct spelling, won't catch errors in hyphenation
Cornucopia Software Box 6111 Albany NY 94706 (415) 893-0633	Electric Webster	For CP/M-based computers and all TRS-80 models, 50,000-word dictionary, suggests correct spelling	Perfect Software 1400 Shattuck Ave. Berkeley CA 94709 (800) 227-5488	Perfect Speller	For any CP/M-based system, 50,000-word dictionary, doesn't correct errors in context, won't catch errors in hyphenation
Cornucopia Software (same as above)	MicroProof	For CP/M-based computers and all TRS-80 models, 50,000-word dictionary, corrects errors in context	Sensable Software 6619 Perham Dr. W. Bloomfield MI 48033 (313) 399-8877	Sensable Speller	For Apple and Apple with CP/M, 85,000-word dictionary, suggests correct spelling, doesn't correct errors in context, won't catch errors in hyphenation
IUS 2401 Marinship Way Seussellito CA 94965 (800) 227-0112	Easy Spell	For IBM personal computer, 80,000-word dictionary, displays and corrects all errors in context, won't catch errors in hyphenation	Software Toolworks 14478 Gloriette Dr. Sherman Oaks CA 91423 (213) 986-4886	Spell	For any CP/M-based system, 20,000- to 40,000-word dictionary, doesn't correct errors in context, won't catch errors in hyphenation
Lifboat Assoc. 1651 Third Ave. New York NY 10028 (212) 860-0300	MicroSpell	For CP/M-based computers, 25,000-word dictionary, suggests correct spelling, has difficulty with documents larger than 20K	Sorolm Corp. 2310 Lundy Ave. San Jose CA 95131 (408) 942-1727	Super SpellGuard	For CP/M-based computers, 20,000-word dictionary, doesn't correct errors in context, won't catch errors in hyphenation



John Deere owners last longer.

Once a John Deere owner, always a John Deere owner. Or so it seems.

Bill Hendrickson, for instance, has been riding his 110 Tractor since 1965. And when he does eventually replace it, he, like most John Deere tractor owners, will probably stay with John Deere.

But that's not surprising when you know how they're built.

Even the smallest John Deere lawn and garden tractors have features like solid steel frames and cast-iron axles with heavy-duty spindles and bearings. Their dependable 4-cycle engines, ranging in size from 10 to 16 hp, are enclosed and isolated for a smoother, quieter ride. And John Deere offers dozens of durable power-matched attachments including center-mounted rotary mowers with 38- or 46-inch cutting widths.

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with artificial intelligence will require the complex calculations and huge memory banks practical only with VLSI. I've recently visited several firms involved in advanced VLSI. It's clear that superchip technology is already producing awesome results. But advances during the next decade promise developments that can hardly be imagined now.

Birth of the chip

This rapidly evolving technology got its start in 1958. Before then, electronic circuits could only be made with discrete components—for example, pea-size transistors, half-inch-long resistors, capacitors, and other components—installed and soldered on circuit boards. Computer circuits required labor-intensive, costly assembly of a great many separate components.

But in 1958, Jack Kilby at Texas Instruments devised a method of building a complete electronic circuit on a single piece of semiconductor—an integrated circuit. The following year, another IC pioneer, Robert Noyce at Fairchild Semiconductor, unveiled another technique of forming circuits on slabs of silicon and interconnecting them. By the 1960s, the race was on to pack more and more components onto ICs.

An integrated circuit performs the same functions as circuits with much larger discrete components. So-called monolithic ICs are made in interconnected layers on a silicon wafer. For each layer, the wafer is coated with a chemical called a resist. Images of circuit patterns are then projected onto the resist (see diagrams), which acts like photographic film, recording each layer of the circuit. Subsequent steps expose sections of the silicon wafer by chemically dissolving portions of the resist. Exposed silicon areas are modified (doped) with different materials to create transistors, resistors, diodes, and capacitors. A thin layer of metal evaporated onto a layer of insulating material interconnects components through holes in the insulator.

A large wafer can hold hundreds of chips made simultaneously on its surface. And each chip may have hundreds or even millions of electronic circuits to perform the function it was designed for. As more circuit functions—memory, computing, data timing, for example—are squeezed onto a chip, the space they occupy as well as their cost are reduced. Since the components are packed together so tightly, signals can pass very rapidly from one chip circuit to another. This density also boosts reliability, since most connections are part of the IC itself. And each tiny chip requires minuscule amounts of power compared with circuits using discrete components. As IC transistors become smaller they require less power and, within limits described later, can operate faster.

There are obvious advantages in packing as many components and circuit functions as possible onto each chip. To accomplish this, the dimensions of components within ICs have been shrinking about 11 percent each year. During the early 1960s, component dimensions on ICs were about 25 microns (thousandths of a millimeter) wide. Today, circuit features on chips are typically three microns wide, although Hewlett-Packard has moved to 1.5-micron technology for its new 450,000-transistor microprocessor chip (see "Science Newsfront," this issue).

VLSI superchips carry more components than large-scale-integration (LSI) chips: For computing functions, VLSI transistors are grouped into logic-gate circuits, each with an average of three transistors. One function of a log-

ic gate might be to deliver an output signal only when it receives two input signals. Definitions vary, but chips with more than 2,000 logic gates are usually considered VLSI. Less-complex microcircuits, down to 100 gates, are LSI. Semiconductor memories, with less-complex circuits for each memory element, are defined differently.

As IC-component size shrinks each year, doubling the scale of integration, VLSI circuitry becomes overwhelming. "Given the complexity of these circuits, the number of hours needed for human design alone would be virtually impossible," says Barry Cohen, manager of corporate computer-aided design (CAD) support services at Intel Corp., a leading superchip manufacturer.

Recently, at Intel's Santa Clara, Calif., headquarters, I saw how important computers have become in VLSI design. Navigating a maze of shoulder-high office partitions, I spotted desk-top CRT terminals, linked to a main-frame computer on the floor below, as often as you'd see typewriters in most offices. Designers scrutinized large-circuit blueprints and intricate patterns on CRTs.

Cohen described the CAD programs Intel uses to check circuit performance before a pattern is etched into silicon. One program simulates the electrical performance of more than 2,000 transistors; another tests the logic operation of tens of thousands of gates. CAD verifies circuit layouts, ensuring that parts aren't too close or components don't overlap. "Other programs verify that what was laid out is actually achieved with electrical connections," he said.

At Intel, an initial series of silicon wafers for a new chip design are run off a production line. "If yields aren't where they should be or performance isn't what's desired," Cohen said, "engineers feed data about defective chips back to their computers." Yields—the number of good chips on each wafer—are critical for a company's economic survival and are closely guarded secrets.

As information about chip designs that reduce yields is fed back to CAD programs, the programs become "smarter" at pinpointing problems in other new chips.

Design-program diversity

Computer programs for creating superchips have evolved into several categories. One type of CAD program uses so-called standard cells. These are sections of circuits, such as logic gates or memory, that are stored with the CAD program. A customized chip for a specific function can be ordered somewhat like an auto dealer orders a car for you. While a dealer requests standardized transmissions, engines, and other components, a chip customer tells a VLSI firm what the microcircuit must do. The CAD program then calls the proper standard cells from its library. Just as a car manufacturer ensures that a transmission maximizes performance from an engine, the CAD program selects standard cells that work best together.

The newest type of CAD program is called a silicon compiler. Continuing the analogy to cars, a compiler is similar to having direct access to an auto maker's engineering-design department: You describe your dream car and the department starts from scratch to design and build it.

As car designers turn to engineering fundamentals for the most efficient design, the silicon compiler arranges basic computer circuits in their most logical arrangement. The silicon compiler designs a chip by first organizing its overall functions into blocks—areas that will eventually become rectangular sections etched into the chip surface. Then the compiler figures out how to fill these blocks with

Continued

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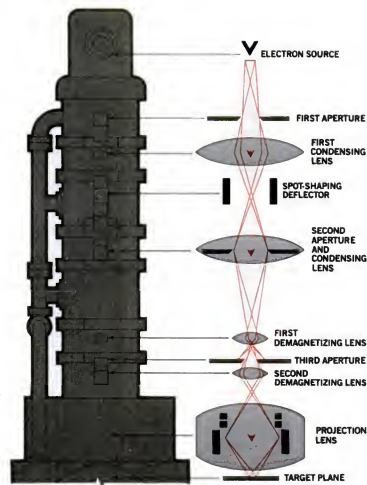
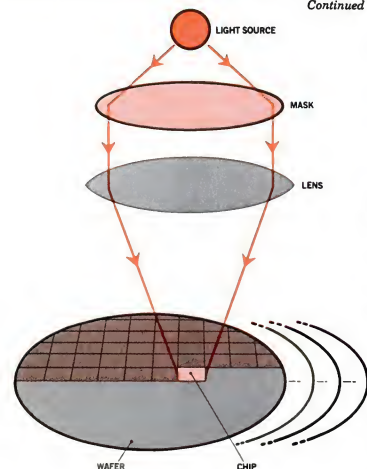
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I. SUPERCHIPS

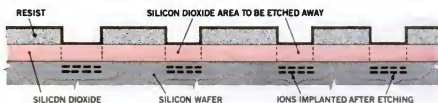
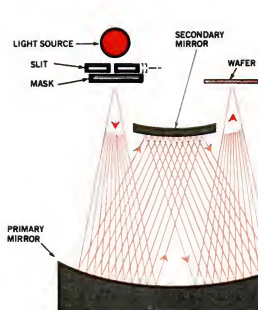
circuits and wire the blocks together. Because they are so new, VLSI compiler programs are just coming into use.

Many chip manufacturers, including IBM at its East Fishkill plant, use a third type of CAD program oriented toward master-slice or gate-array technology: These are partially completed wafers with the chips finished except for several of the top layers. Depending on a customer's needs, a CAD program determines how these topmost chip layers will be connected. These final connections alter how the array of logic gates on each chip functions. The technique might be compared to a car maker preparing many chassis ahead of time, then altering the final product by

Continued



Electron-beam tools (above) draw intricate circuit patterns on stencil-like masks coated with a liquid plastic called a resist. After processing, mask patterns are projected onto resist-coated silicon wafers. A wafer, such as the one at left, carries many tiny chips, each a complete circuit. A dozen or more mask exposures, alternated with processing outlined below, create chip circuits like layers on a cake. Ultra-thin electron beams, guided by a computer, can also write patterns directly on wafers, bypassing masks. But this is too slow for high-volume production. A faster process, called **step-and-repeat** (left), uses projected light. Masks created for a single chip instead of a wafer, and up to 10 times the size of a chip, project patterns on a wafer. The wafer is then moved slightly and the adjacent chip pattern is exposed. Resists sensitive to light instead of electrons are used. Because they're optically reduced, defects that might spoil other fabrication processes may go unnoticed in step-and-repeat masks.



Full-field projection (bottom left) is an older lithographic process that's faster than step-and-repeat: A narrow slit passes before an intense source of ultraviolet light, projecting a mask image of an entire wafer onto the silicon disc through a system of curved mirrors. After each exposure, etching with chemicals or streams of ions removes some resist areas. This exposes the layer beneath the resist (figure above). Chips are made with layers of insulating material such as silicon dioxide, metal interconnections, and doped regions—silicon with atoms diffused into it that alter its electrical properties. Wafers may be heated red-hot in furnaces, with gases released inside for doping; or ion implanters, accelerating dopant atoms with high voltages, may spray the wafer surface. A laser or diamond saw cuts individual chips from the wafer for final electrical testing.



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You know how fresh and vibrant the air feels right after a rainstorm, in the mountains, or near a waterfall. That clean, alive fresh air is rich in something important that is greatly depleted in our urban and indoor air. That missing element is negative ions, nature's own air cleaners. Many users experience great benefit from these amazing active ions, including feelings of aliveness, alertness and vitality similar to that experienced in the fresh mountain air. In addition, even hospitals use ionizers in some units.

Filter fan units do not emit negative ions. The COLLECTOR, by Zestron, creates trillions of these beneficial ions every second, while giving you the best performance, value and technology in air cleaning.

THE ZESTRON BREAKTHROUGH!

Most ionizers clean your air but leave an untidy deposit of pollutants on room and furniture surfaces near the ionizer. The COLLECTOR by Zestron takes ion technology a giant step forward by giving you super-powered ion output while depositing pollutants from your air on the collector panel. This easy to clean panel features a scientifically formulated surface that electrostatically attracts the vast majority of indoor pollutants to it rather than to the floor or walls near the ionizer. Other bipolar ionizers with porous collecting surfaces that absorb odors and unsightly grime are almost impossible to clean.

AMAZING DEMONSTRATION!

Unplug your COLLECTOR, place the ionizer unit and an ash tray on top of the panel. Place a lit cigarette in the ash tray and watch the smoke rise into the air. Now plug it in, and amaze yourself and friends as the smoke barely rises above the ash tray and then nose-dives onto the collector panel before it can enter the room air. This is accomplished entirely electronically with no moving parts! The COLLECTOR by Zestron is the only ionizer on the market that cleans the air powerfully enough to accomplish this test.

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The COLLECTOR by Zestron is the only bipolar collecting ionizer with superpower output. The thoroughness and speed of air cleaning increases with more ion output, and Zestron ionizers give you the highest output (without detectable ozone). Check the comparison chart below. Note that many of the other ionizers on the market do not come equipped with a COLLECTOR or do not state ion output as measured in the industry standard of ions/cc/sec. at one meter.

IONIZER	ADVERTISED OUTPUT (1 m.) ions/cc/sec.	COLLECTOR
The COLLECTOR by Zestron	1,200,000	YES
JSA Bubble	not stated	YES
Orbit	not stated	YES
AirCarel	236,000	YES
Ion Fountain	540,000	NO
Ion Cloud	350,000	NO
Ionosphere	350,000	NO
Modulian	75,000	NO
Ion Breeze	not stated	NO

FREE ION DETECTOR

A FREE remote ion detector comes with each ZESTRON to verify and compare output. When you place the detector next to a ZESTRON and a competitive unit, you will see greatly reduced or no output from the competitive unit!

SATISFACTION GUARANTEED

Order a COLLECTOR now and try it in your home or office risk free for 30 days. If for any reason you are not satisfied, return the unit for a full refund including return postage. The COLLECTOR has a full one year warranty on both parts and labor excluding abuse.

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Reorders are pouring in, customers write: "We are enjoying the results of the first one and are ordering two more" Dr. J.B., M.C.—CA; "I'm a distributor for three other ion companies, and have to say I am extremely, extremely impressed!" T.N.—CA.

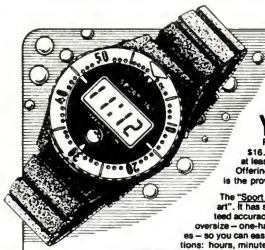
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I. SUPERCHIPS

varying the parts put on top of them.

One disadvantage of this master-slice technique is that many of the gates may go unused for a particular customized chip. But the advantage is that orders for custom chips can be delivered rapidly.

Computers on the line

As VLSI chip structures grow ever narrower, computers are also being used on production lines to maintain ultra-precise control of manufacturing equipment. At its East Fishkill facility, IBM uses them to collect extensive data about each wafer during the production process. Big main-frame computers are tied to smaller models controlling factory areas, which in turn "talk" with microcomputers built into individual production tools.

IBM's Mayo, who supervised the installation of microprocessors in manufacturing tools at East Fishkill a few years ago, stressed the advantages of having computers in each piece of equipment. In one small room a furnace was heating a tray with up to 200 wafers. The silicon discs glowed red. "By using computers to control the temperature and time it takes to go from one temperature to another, you avoid the buildup of stress that can cause a wafer to bow," he said.

As the wafers heat, impurities injected into the furnace atmosphere diffuse into the silicon. To shorten the exposure of wafers to high temperature, one trend is to boost the pressure inside the furnace, Mayo said. Higher pressures speed the diffusion process, permitting lower furnace temperature. "Another trend is away from hot processing to ion implantation," he said. This technique avoids temperature stress on VLSI wafers altogether by adding impurities with a beam of ions.

We passed dozens of super-clean rooms where workers wore lint-free gowns and caps to reduce dust. To enter these rooms, Mayo would even have to cover his gray-flecked beard to avoid potential contamination of VLSI wafers.

At one point along IBM's automated line, I watched resist being applied to a wafer. Under computer control, a tiny arm swung into place over a gray, four-inch wafer. A measured amount of clear viscous resist was squirted onto the surface. The arm was withdrawn, and the silicon disc began spinning, smoothing the fluid.

Continued

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Only SuperFone 650 has a secret code system to prevent interference and false operation of the phone. You choose from 512 possible "code" combinations. Both the base unit and the phone are locked onto that code, which you can change when you want to.

No other phone can interfere. No other unit can share the signal. No one else can hear or speak on your carrier-wave.

Enormous Range

We say the SuperFone 650 has a range of 1500 feet.

Notice we didn't say "up to" or "as far as" 1500 feet. There's no hedging, because this seems to be the minimum, not the maximum range.

Users report 1800 and 2000 feet. That's nearly half a mile. SuperFone 650 is a radiophone, not a toy, and that's why its signal doesn't break up or start hissing or crackling when you get half a block away.

You can tell when you hear it. It's a little Giant. You can feel the power inside. What a marvel of electronic engineering it is! And it's tough, too. It fits into your shirt pocket, and you can bounce it around all day without damaging it.

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SuperFone 650 is The Everything Phone. Anything any phone can do, it can do.

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The LISTENER is small, unobtrusive, not the kind of thing anyone would look at twice. But plug it into any modular phone outlet and it gives you an open ear into what's going on, foot by foot in the world.

Visualize this: You're a few blocks away and want to know if the baby is awake. Dial your number. The phone won't ring, so no sound will disturb the baby's sleep. But your "beeper" puts a signal into the line, turning on the LISTENER.



What a powerful listening device it is! The LISTENER will pick up not only a baby's whimper but water running in the tub 80 feet away. Suppose you suspect that because you're out of town your employees are playing poker in the office at night. Call from any phone. The LISTENER will tell you. It also will tell you if a piece of equipment is operating. If you're not invited to a meeting in your conference room, go anyway; the LISTENER will send you every word, wherever you are.

The LISTENER can save your property - and even your life. Suppose you're coming home late at night and think you see a shadow inside your home. Go to any phone and call. If there's a sound, you'll hear it. The LISTENER is your silent, hidden watchman!

Private detectives have dreamed of such an electronic eavesdropper. They want it for more exotic uses than you do, but the LISTENER will give you peace of mind you never had before. The kids said that while you're on vacation, they'll be in bed by eleven. Are they? One quick call will tell you.

Call From Anywhere in the World

Plug the LISTENER into any modular phone plug, out of sight, and forget it until you want to use it. Carry the beeper with you. What security you'll feel, knowing you can "tune in" to your home or office whenever you like.

The complete LISTENER, including beeper, is \$199.95, plus \$2.50 shipping. Peace of mind is worth ten times that. Don't you agree?

The Telephone Voice Changer

It's right out of James Bond! Push a button and the VOICE CHANGER gives your voice completely different characteristics. The person on the other end of the phone won't know it's you.

The VOICE CHANGER is more than an "electronic handkerchief" - it doesn't cause your voice to sound filtered. It literally changes tone and timber.



Choose from two separate, distinct Change Channels. If you're alone in a business office, it'll sound like an employee answering. If you live alone, you can get rid of pesky calls by pushing Channel 1 or Channel 2 and saying, "Sorry, that person isn't in."

How It Works

The VOICE CHANGER is powered by two ordinary penlight batteries. One set of lead-in wires connects to your telephone base; the other clips to the wires leading to the handset.

Pushing the button labeled "Ordinary" puts your normal voice through the line. Pushing "Channel 1" changes timber and texture. Pushing "Channel 2" creates different characteristics from Channel 1. Thus you have three voice options - your own, plus two changed voices.

MAKE NO MISTAKE! THE VOICE CHANGER DOESN'T MUFFLE YOUR VOICE OR MAKE IT UNINTELLIGIBLE. It literally changes the quality of sound - space-age electronics at work.

Use the VOICE CHANGER to reach that doctor, lawyer, or business executive whose secretary knows your voice and who always is "out" when you call. Use it to screen your own incoming calls. Use it for just plain fun. Any time you like, during a conversation, push the "Ordinary" button and your regular voice returns to the wire.

The VOICE CHANGER is yours for \$99.95 - two for \$99.95 each (Plus \$2.50 shipping per total order). When you consider the many uses of this brilliant electronic instrument, it's a real bargain! Of course it has the standard New Horizons guarantee.

The Super Ear

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SUPER-EAR is undetectable from the other side of the wall. The quality of sound has amazing fidelity - good enough to record, and SUPER-EAR has its own built-in recorder jack.

Because SUPER-EAR is the ultimate listening device, you can use it to pinpoint hidden squeaks in your car or the source of mysterious engine noises. Construction experts use it to check for flaws or cracks in buildings.

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A Complete Phone Answering System
If you press the "Prefix" key, the "Clear" key, the Direct Memory Keys, or any of the other special function keys (more about these later), your Phone Voice tells you what you've pushed. If you get tired of company, you can shut off the voice; but it's like having a friend right inside your phone.

This feature takes some explaining.
In the bank of keys to the right of the dial pad are three marked M1, M2, and M3. M1 and M2 will tell a caller, when you're out, either when to call back or another number where you can be reached.

What about M3?
M3 makes any cassette recorder an answering device. Using the connector (supplied), your recorder can take messages up to the total length of any tape cassette. The Everything Phone turns the recorder on and off automatically when a call comes in.

So—you have your voice of 1) a message, in the phone's own voice, to call back at whatever hour you designate; 2) a message that you're out and can be reached at whatever number you designate; 3) an invitation to leave a message after the tone, with a capacity as long as the cassette—an hour or more.

Memory Keys Galore for Automatic Dialing

At the left of the numeric keypad are ten Direct Memory Keys. The key at the upper left is for MCI, Sprint, or other computer-code dialings. It holds the access number and your personal code number.

The other nine let you dial stored numbers, including long distance numbers, by pressing one key. You can inset a tab showing whose number is stored.

But you ain't see nothin' yet!
You actually can store up to 50 numbers of 20 digits each, using a two-number code. Example: if you already have 30 numbers in memory and you want to store 1-305-473-2044, punch in that number, use the "Store" key and "31", and you'll be able to dial that number in the future just by pressing "31".

Quality Speaker-Phone

Of Course The Everything Phone has one-way speaker-phone capability. Of course it's high quality sound.

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Music on Hold; "Mute" Switch

You can put a caller on hold just by pressing the "Hold" key. What a pleasant surprise! Instead of dead sound, the person on hold hears a pleasant melody. (You'll hear it too, so you won't forget he's on hold.)

You have a "Mute" privacy button, and it couldn't be more convenient—it's right in the center of the modern hand-phone. Press that button, and although the other party won't be able to hear you, you'll still be able to hear him or her. Release the button and communications are normal again. (No tell-tale "click" when you press the Mute button.)

Here's a List of Other Built-In Benefits

Your Everything Phone is an electronic butler. It has—

—Automatic radial. Press this key and your phone will radial the last number you called either once (if the phone is off the cradle) or four times (if the phone is in the cradle).

Each key has a separate function. Each one talks to you, if you want it to. What a conversation piece The Everything Phone is!

- Pulse/Tone selector switch. In areas with rotary dialing only, slide the switch to "P". In areas with touch-tone, slide it to "T".
- Ringer off switch. You can turn off the pleasant "chirper" (it isn't a bell when you don't want to be disturbed. A separate ringer i.e.d. light will alert you, if you're interested).
- Access pause key. For Sprint, MCI, and other code numbers, the Pause button gives you the proper gap between the original dialing and the time the system takes to answer with a tone. The Pause has other uses, too, but we just can't list all of them here.
- Secretarial aids. Open a little door and you have a memo pad to jot notes. For the numbers stored in automatic dialing memory, slide out the Directory Card, concealed under the phone unit.
- Battery backup. Two tiny, easily replaceable batteries keep your memory intact. A power failure, even one that lasts for months, won't wipe out what's stored in the memory.

Anything Else?

Probably. We ourselves haven't figured out all the phone assistance The Everything Phone can give you. But we do know this:
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PS43

I. SUPERCHIPS

After baking to remove excess solvents, this resist coating is perfectly flat.

Normally, each resist coating is used to record a portion of the circuit pattern. But resists can also solve a problem caused by the growing density of VLSI components. "As you make resolution smaller and smaller in the horizontal direction, it also diminishes in the vertical dimension. If you don't have flat wafers, you don't have a process," Mayo said.

One technique now used to guarantee micron tolerances of flatness for VLSI wafers is to use a resist layer to achieve a very smooth surface. Another resist coating atop the first then precisely captures the image of a circuit pattern.

Another problem arises with the chemicals used to etch these circuit patterns. Wet chemicals, etching in all directions, undercut exposed portions of the resist. This creates curved walls down to the next wafer layer. And that limits how closely VLSI components can be packed together. "One trend is to get away from wet chemistry and use dry processing," Mayo said.

Dry processing "develops" patterns on special resists by exposing them to ion bombardment in a vacuum. The ion field can be vertically aligned with high voltages; its sandblast effect etches resists without undercutting them. The result is greater circuit density.

Smaller than light

In a small room at Bell Laboratories in Holmdel, N.J., I discovered that clever tricks with resists also play a role in developing the next generation of VLSI circuits. This winter, Bell Labs, which developed the first transistor, announced the smallest transistor element yet made.

The darkened lab was dominated by a desk-size electron-beam device. To make VLSI components smaller than about 0.5 micron (the wavelength of light), electron or X-ray beams are often used.

Bell Labs researcher Howard Johnson explained that narrow lines on the CRT screen of the electron-beam device represented circuit features only hundredths of a micron wide.

"What normally limits electron-beam lithography is the electrons coming in, hitting something, bouncing back, and fogging the resist," the young researcher said. Bell Labs side-

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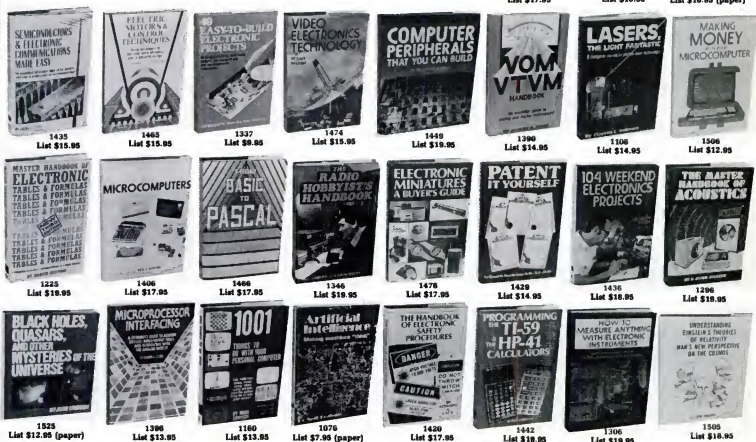


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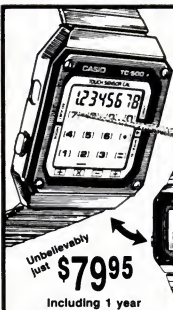
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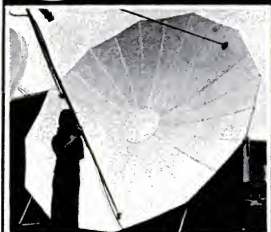
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I. SUPERCHIPS

steps this electron backscattering with various techniques requiring multiple layers of resists. One method is to deposit a resist on a silicon wafer, then put a second resist layer on top. The function of the bottom layer is only to lift the other coating far enough from the wafer to minimize backscattering and fogging.

Such techniques enabled Bell Lab researchers to develop an experimental transistor with one element only 0.07 micron wide. This dimension enables the transistor to operate very fast. But high speed and future VLSI chips with such extraordinarily small elements face limitations from overheating. High-speed signals passing through VLSI chips can destroy them because conductors connecting the circuits are so small. Effective current density is very high. "Already, ICs are carrying currents of many thousands of amps per square centimeter," Johnson said.

"That's why people are interested in superconducting computers—because they have no such limitations," he added. In superconducting computing devices, such as the Josephson junction ("Superconductors," PS, May '81), the resistance in elements drops to zero: Extremely high computing speeds, which cause current flow to soar, are possible without burning out superconducting chips.

But basing future VLSI on superconductors may not be practical. Cumbersome liquid-helium plumbing is needed to achieve superconductivity. So some firms are following another route: gallium arsenide superchips. This material is far more expensive than silicon, but its crystalline structure enables electrons to flow through it more easily. The result is that signal speeds can be significantly higher.

Silicon and other solid-state materials such as gallium arsenide are likely to be the mainstay of VLSI for some time. But a number of researchers, including some at IBM, are studying how biological molecules capable of passing electrons between themselves can be literally grown into practical computing circuits. A future class of VLSI circuits may be biological rather than solid-state. Not so exotic but also intriguing is a VLSI candidate based on photonics [PS, May '82]. Photonic devices carry signals in the form of light and promise extremely fast, low-heat computing circuits. Much research remains, however, before biological or photonic VLSI becomes a reality. **■**

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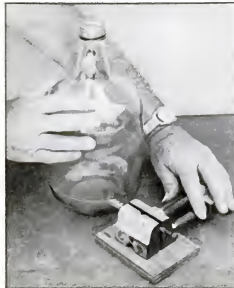
This old house revisited



Above, striking off the slab for the new solarium that joins the detached garage to the tract house featured in this issue, is a refreshing new show-biz personality, Boston renovator Bob Vila.

I first "met" Bob the same place you probably did—on public television's how-to-do-it series, "This Old House." When I expressed interest in the particular remodeling job he did on a recent series (you can still catch reruns on scattered stations), Bob dropped into our offices to chat about the project. I later met him again at a home-improvement show where he was ad-libbing his lecture because the show's management had provided no outlet where he could plug in his projector. His audience didn't miss the slides at all as they called out questions about jobs they'd watched him perform. They all acted as though he were a trusted colleague—someone they'd worked beside on home-improvement projects.

Bob Vila invites that kind of informality.



He wears his new fame as easily as that quilted vest he often sports. Though past series have been filmed on a tight budget—and at a frantic pace—that would give most of us nervous jitters, Bob seems always confident that every problem can have a prompt solution.

Happily, the path of his current series has been smoothed with an underwriting grant from Owens-Corning Fiberglass Corp. Like PS, O-C is dedicated to the "Don't move—improve!" approach to home ownership, and as do-it-yourself involvement in remodeling and retrofitting steadily increases, we need shrewd and talented idea men like Vila to offer stimulus and guidance. With his master carpenter, Norm Abram, Vila should be showing us all how for many months to come. "This Old House" is carried by 90 percent of the PBS network, and I wish it continued success.

Tips for early gardeners

The two photos below were sent me by a California reader, Louis Hochman, who gets a jump on the planting season by making multi-use garden accessories out of gallon-size glass jugs. First he cuts off the bottom of each jug by clamping a standard glass cutter into a drill-press vise so he can rotate the jug against the cutter wheel to score the glass.

Hochman then taps the scored line from the inside with a short bolt attached to a "handle" of stiff wire. Then he taps the bottom free with a stick inserted through the jug's neck and smooths the edge with a carborundum stone.

Both uses of the jugs are shown in the second photo. To protect seedlings from cool nights or predatory animals, just set



a bottomless jug over each plant as a mini-greenhouse. To use as an irrigation system, next morning, invert the jugs and press the necks into the ground until each jug rests on its shoulder. Fill with water or liquid fertilizer; it will seep slowly into the soil, taking hours or even days.

To keep mosquitoes from breeding here, cover jugs with cheesecloth. Or let bugs breed and scoop out the larvae to feed your goldfish, as Lou does.

Back to Texas, builders

The annual convention of the National Assn. of Home Builders returned to Houston at the end of January, after eight years' absence. A major part of this event is a giant building-products expo, with leading manufacturers showing their newest appliances, plumbing fixtures, cabinets, and doors. Since this was the 15th NAHB show I've covered, I can spot industry trends by comparing each year's expo with those of the past.

Optimism was up this year—even though the anticipated upswing in housing starts was not yet confirmed and despite warnings by financial experts that mortgage interest rates wouldn't fall much below current levels.

The displays were as lavish as ever, spilling out of the exhibition hall and into the adjacent AstroDome itself, with booths covering the entire playing field. Even exhibitors who weren't showing any new products confided to me they had prototypes ready for production as soon as economic conditions perk up. The NAHB show remains the one toward which all building-material product debuts are timed, so next January Houston should be awash with innovation.

Meanwhile, this was a year to confirm recent trends. The microwave oven has finally achieved the status of a standard kitchen appliance; among dozens of display kitchens, not one lacked a microwave—countertop or built-in. Of the latter, by far the most popular remains the range-hood type. Though GE started it all, by now nearly every oven maker offers a version of this handy, tuck-over-the-range microwave—either as an independent unit or bracketed above the stove. And don't bleed for GE, because it is "private labeling" its own version for others.

Another trend I spotted at an earlier show is the patio door with the access panel hinged rather than sliding. This is now an option with most door makers; apparently many women find a large double-glazed slider too heavy for easy use.

And in our August '81 issue we reported on a retrofit security door (from Pease) that turned any closet into a walk-in vault. This year's expo showed three other models: One from Benchmark (also sold by Sears) has a push-button lock (see this issue's "What's New in HI") on a hinged panel. Two other vault doors (from HomeSafe and Roll-A-Door) pull down like steel window shades behind an existing closet door. More on these later.

Ceiling fans remain a hot item, and this year one model (from Ritz) was literally so: It boasts a built-in electric heater in its hub.

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Sears, however, was not content to leave well enough alone. So in 1971, Craftsman lawnmowers had the first no-maintenance, replaceable air filter. A big improvement over the sponge filter, which requires frequent cleaning and soaking with oil.

But Sears wanted to make life even easier yet. So a little device called a mechanical compression release was introduced. The result? It made the starting cord easy to pull and the mower easy to start.

What more could you ask for? How about a maintenance-free mechanical governor that helps prevent stalling in tall grass. Or a pressurized lubrication system that continually bathes engine parts in oil. A no-adjust carburetor. And the list goes on.

Of course, you won't find all these innovations on every Craftsman lawnmower, but there's one thing you will find. We'll never stop perfecting the lawnmowers that carry the name Craftsman.

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By ROY DOTY

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Smokey's amazing engine

[Continued from page 84]

at 4,400 rpm. Why would you need any more power for a road car?" But if it's a four they want, it's a four they'll get. Chrysler has provided an Omni for the installation. The results should be interesting.

The engine has been a long time in coming. Sitting in his textbook-lined office out behind what a sign describes as "The Best Damn Garage in Town," just outside the cluttered experimental shop where he does all of his research, Smokey told me about his 30-year quest for a lighter, smaller, more powerful engine. I knew, of course, that he is a master mechanic. That for 30 or 40 years he's worked closely with the big names in Detroit on racing- and production-vehicle development programs. And I had developed articles on advanced new engines with him several times since he became a POPULAR SCIENCE contributing editor—years ago.

Absence of cooling

"I became intrigued with the idea of an engine made of materials that wouldn't require a cooling system," Smokey recalled. The current, Phase I engine is the first step toward achieving a more thermodynamically efficient engine. In Phase II, he will make greater use of ceramics to handle the increased operating temperatures. Smokey has been working for some time with silicon carbide. Nearly as hard as a diamond, it resists distortion even at extremely high temperatures. In addition, it's exceptionally smooth and requires only a minimum of lubrication.

In the Phase III engine, internal temperatures will be too high for conventional mineral-oil lubricants, and a high-temperature-resistant synthetic will have to be substituted. Cylinder-wall temperatures will be almost 900 degrees F. Conventional gasoline engines seldom run cylinder-wall temperatures higher than 250.

The Phase IV engine won't have any cooling system. In that power plant, Smokey's goal is to achieve 85 percent thermal efficiency. Typically, spark-ignited engines use only 25 percent of the thermal energy in the fuel they consume. The rest of the energy is blown out the exhaust or dissipated by the cooling system. That means that of the 110,000 Btu in a gallon of gasoline, only 27,500 reach the crankshaft as useful work.

In an energy-starved world, anything that improves that ratio is going to be warmly welcomed. □

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The Button is a solid-state micro chip diode. It converts AC current to DC current and extends the life of a bulb filament up to 100 times!

For example, a regular bulb rated for 750 hours would last for about 32 days if burned continuously. But, with The Button, that same bulb's life would be extended to 75,000 hours or 8 years! In typical part-time home service, you may never have to replace it!

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This amazing development works with any regular incandescent light bulb up to 400 watts, (except 3-way bulbs) including small-base candleabra bulbs.

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The Button is absolutely ideal for lights that run 24 hours a day like exit signs and security lights. (Don't replace them until 1990!) Major hotels, restaurants and corporations are already using The Button and saving considerably on maintenance costs.

The Button has no moving parts so there is nothing to wear out. All materials meet or exceed U.L. standards and each Button carries a 10-year warranty.

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Do not confuse The Button with inferior thermistor devices. They absorb electricity and heat up dangerously in order to be effective. Even then, they extend bulb life only slightly. By contrast, The Button is a microchip diode. It rectifies alternating current to extend bulb life up to 100 times. What's more, The Button uses a centering disc manufactured of U.L. listed G.E. Noryl® and is engineered for safety.

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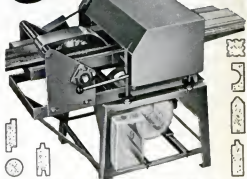
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MARINE SURPLUS DEPOT BCRB—11

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Ignition interrupter

thwarts car thieves

It's easy to install, costs less than \$20, and may reduce insurance rates

By JACK KEEBLER

Car thieves are having another record-breaking year, according to the latest police statistics.

But an ounce of prevention may save you from becoming another number on a police "hot sheet." For under \$20, and in less than an hour, you can install an ignition-interrupting device. Shutting off your motor opens a circuit in the vehicle's ignition system, making it impossible to start the car. Even if the thief has the key or attempts to "hot wire" the ignition, the engine is disabled. Only you know your car's starting secret.

Kolin Industries, Inc. (Box 357 G, Bronxville, N.Y. 10708) manufactures and markets a device appropriately called Big Stop. Using the unit, the company claims, can reduce comprehensive insurance costs by up to 15 percent. Installation is easy, even if you don't know a diode from a relay.

Step 1: To pass Big Stop's orange and gray wires through one of the previously existing holes in the fire wall, puncture the plastic grommet that seals the hole using a sharp, pointed tool. Pass a coat-hanger wire through the hole, then bend the end sharply.

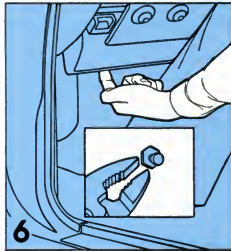
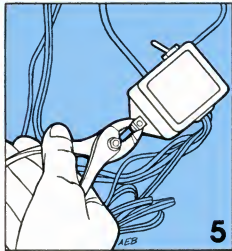
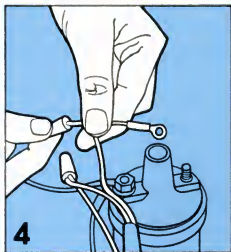
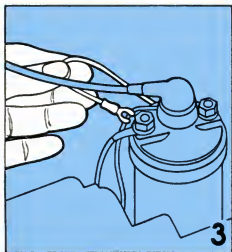
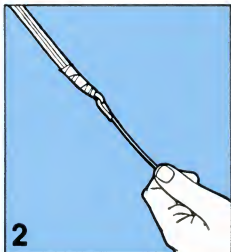
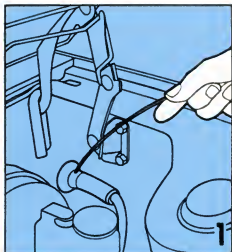
Step 2: Working from inside, fasten the orange and gray wires to the hooked end of the wire with electrician's tape. Pull the hanger back through the hole with the attached wires. Tape the wires to existing wiring to avoid damage from moving parts.

Step 3: Remove the wire that's connected to the negative terminal of the coil. Connect it to either of the gray wires, and connect the other gray wire to the terminal. Connect Big Stop's orange wire to a "switched" 12-volt wire (without voltage until the ignition is turned on), such as the positive terminal of the ignition coil.

Step 4: Secure the wire connections with tape and wire nuts.

Step 5: Use mounting screws to install the black box on the back side of the dash panel. (Make sure the toggle switch is still accessible.) Attach the black wire from the box to a grounded metal part of the dash. Slip the push button through a previously drilled $\frac{1}{32}$ -inch hole. Install the retaining nut.

Step 6: Push the button and turn ignition on. Unless a thief knows where the concealed button is positioned, or that it exists at all, your car is safe from any unauthorized start. ■



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Its custom-made, powerful micro-chip circuit replaces 5600 transistors and makes Pulse Tach the most advanced pulse instrument ever developed for consumer use.

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Pulse Tach Fingertip Heart Computer is just two inches long, weighs about an ounce yet it represents a major advance in personal electronics.

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You must require only a few hours of spare time per week and must have realistic annual profit potential of \$40,000 or more

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His writings have been used in numerous style and content workshops and accredited courses at such institutions as California State University, UCLA, Fordham, University of Illinois and Worcester Polytechnic Institute.

Naturally, you're wondering what all this is — but I'm not going to tell you here. No, it's going to cost you ten smackers to find out. But I will tell you what it isn't so you'll not be off on some wild goose chase:

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Other than my step-by-step detailed report ... nothing. I have thought long and hard about it; A person virtually without a shirt on their back or a pot to plant petunias in could do it. You will of course, have to put my plan into motion — but that's both fun and easy and totally accomplished from the comfort of your own home. (By the way, no one will be coming to your home, either.)

Finally, let me make this clear: Once you have my report, that is all you need to get going! I have nothing else to sell you for this deal. Your purchase of this extraordinary report is NOT a "foot in the door" to get you to buy some extra or expensive "course" or whatever ... this is all you need from me!

WHAT TO DO NOW

You've got several choices:

1. Write or phone me and try to pry out the details for free. It won't work, but what the heck — here's my number: (517) 655-3333.
2. Put this ad aside, wait 90 days or so and lose your chance at \$100,000.
3. Do the only sensible thing. Send me the ten bucks and get started on wearing in that path to the bank.



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P.S. One more thing (say, this Du Vall is a windy so and so, isn't he?). There are lots of people right now in bad financial straits. I hope you're not one of them, but if you are, having read this ad you now have absolutely no excuse for being broke, because as the saying goes "This is it!" This could truly be the once-and-for-all solution to any money miseries you have. I guess you'll have to take my word for it until you receive these fabulous reports — but if it eases your mind any, over 100,000 men and women worldwide have been, over the years repeat buyers of my books, manual, reports, cassette tape programs and newsletters. There must be a reason ...

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